MARCH 2025

Aerospace TESTING INTERNATIONAL

Inside this issue

// HYDROGEN ON HOLD
What now for hydrogen electric propulsion after Airbus delays its 2035 entry-into-service target?

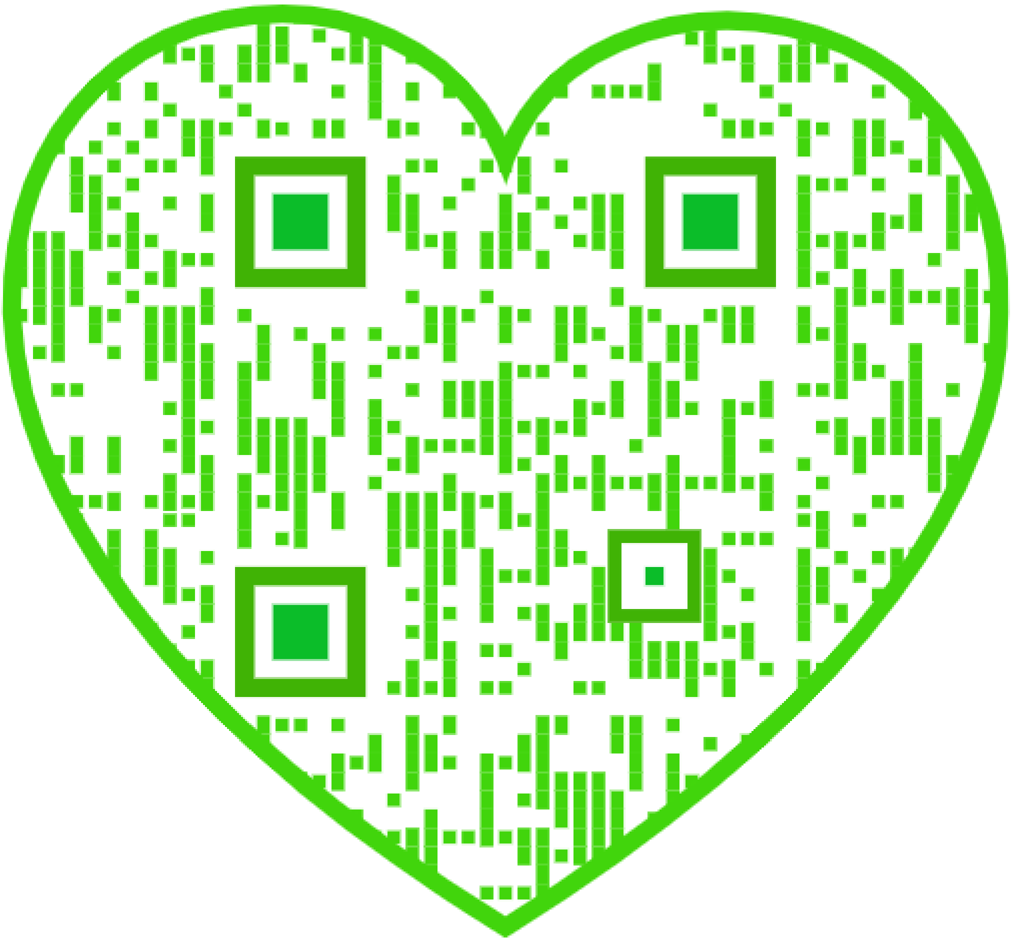
// SKY HIGH
Unmanned aircraft operations in the stratosphere are about to take-off after years of ground testing

// NDT & AUTOMATION
How robotics and AI combine to increase accuracy and improve the efficency of inspections

Dream delivery

Lead engineers on the Dream Chaser program reveal how the spaceplane has been stress tested ahead of its first launch

WWW.AEROSPACETESTINGINTERNATIONAL.COM



CURTISS-WRIGHT

Reduce Risk and Expensive Delays with Proven Comprehensive Flight Test Instrumentation Solutions

Curtiss-Wright guides you from system design through program completion with quick worldwide support when needed. A full range of easy-to-integrate products are available that deliver high-quality results flight after flight:

- Data acquisition units
- Ethernet / Chapter 10 recorders
- Network switches
- IADS display and analysis software
- Space instrumentation
- Integrated cameras and video recording systems
- RF telemetry transmitters
- Flight termination systems
- Radar enhancing transponders
- TSPI systems and FTI power systems

curtisswrightds.com/fti

Global briefing

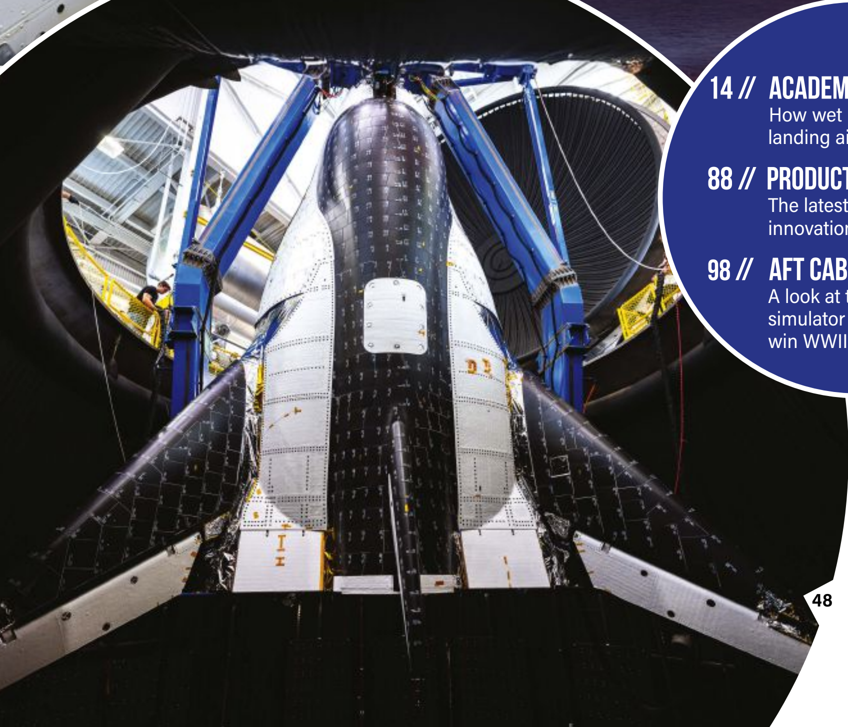
6 // **WORLD TEST UPDATE**
The latest testing news from around the globe

8 // **777-9 GETS HOT & HUMID**
Boeing's latest airliner travels for flight tests

11 // **AFRICAN FLIGHTS**
The Zephyr HAPS has made its maiden flight from its new base in Kenya

12 // **SUPERSONIC DIAMONDS**
NASA's X-59 Quesst has passed key engine testing programs

24
CAE
Piper



14 // **ACADEMIC INSIGHT**
How wet runways impact landing aircraft

88 // **PRODUCTS AND SERVICES**
The latest product innovations and company news

98 // **AFT CABIN**
A look at the early flight simulator that helped win WWII

Inside this issue

16 // ***Ground breaking***
Gulfstream's R&D campus uses the latest testing technology to improve its aircraft

24 // ***Electric Archer***
A Canadian company has high hopes for the electric mod for its training aircraft fleet

32 // ***Hydrogen hiatus***
Airbus' change of direction demonstrates the difficulties in developing hydrogen fuel cell powered aircraft

40 // ***Testing Talk: Wright Electric***
Jeff Engler and Colin Tschida, CEO and CTO of Wright Electric, discuss their electric aircraft development

48 // ***Shuttle returns***
A detailed look at the Dream Chaser spaceplane's structural and vibration testing

56 // ***Stratospheric stations***
High Altitude Platform Stations are being flight tested and will soon enter into service

64 // ***AI and the Aerospike***
Work on an alternative rocket engine design has been reinvigorated thanks to the latest advances in computing

72 // ***Innovative inspection***
Robotics and AI combine for NDT applications in aerospace

80 // ***Testing without breaking***
Analyzing the latest technology and processes for nondestructive testing

// MESSAGE CONTROL

The nature of a public company demands that an announcement is made when there is a major change in strategy. But a good public relations department will always aim to spin communications to be advantageous to the company.

Thus, in the weeks leading up to Airbus' annual press conference last month, executives quietly leaked the news that the European OEM is to scale back major parts of its R&D program. The date for the entry-into-service of its hydrogen aircraft was pushed back ten years and its eVTOL aircraft development program paused.

During the press conference Airbus CEO, Guillaume Faury was asked repeatedly about the change of strategy by journalists, who for the last four years have been fed a message that hydrogen fuel is the future of Airbus and the industry. Faury did an admirable job controlling his peevishness at the line of questioning. There were hints of his disappointment at having to scale back the company's plans in his responses. There was also a reluctance to admit that Airbus had been overambitious with its 2035 target for hydrogen.

Nevertheless, the reasoning behind Airbus' decision is difficult to dispute – that neither hydrogen nor eVTOL aircraft can be commercially viable products for them in the next ten years. The technology is achievable, but what's the point if the result is either unsuitable (eVTOL aircraft) or unusable (hydrogen fuel-cell aircraft) because there is no fuel available?

Although the details and drivers are different in each case, hydrogen's development as an aviation fuel, battery-based electrification, and the introduction of eVTOLs share a common challenge. That is, unless there is money to be made or saved, companies will not deliver these technologies.

The nature of aerospace development has different demands to those of running a profitable business. The two aren't incompatible, but an ongoing balance must be struck. Testing and development costs increase as products mature. Realistic decisions must be made. That truth can be seen in several articles this issue, as well as in the Airbus decision last month.

Ben Sampson
editor

> **AEROSPACE TESTING INTERNATIONAL IS THE WORLD'S ONLY PUBLICATION DEDICATED TO THE APPLICATION OF TESTING, EVALUATION AND INSPECTION IN THE AVIATION INDUSTRY. THE MAGAZINE AND WEBSITE PRESENTS THE LATEST NEWS, SPECIALIST FEATURES AND INSIGHTS ON THE NEW TECHNOLOGY AND TEST PROGRAMS MOST RELEVANT TO THOSE WORKING IN CIVIL AND MILITARY AEROSPACE, LAUNCH VEHICLES AND SPACE PLATFORMS**

// Contributors

JACK ROPER

Jack Roper is a freelance writer based in rural Dorset. A former English teacher, he enjoys learning about new topics, telling stories and writing accurately.

JOANNA BAILEY

A seasoned aviation journalist and editor, Joanna regularly contributes to some of the industry's leading publications with insightful, first-hand stories.

PAUL EDEN

Editor of the *Official Royal Air Force Annual Review* magazine and *Salute* historical journal, Paul is a dedicated aerospace writer, editor and blogger.

GRAHAM JARVIS

Graham is a freelance business and technology journalist, whose key topics include automotive, aerospace, IT/ICT, economics, politics, defense, and global financial markets.

// The team

EDITOR Ben Sampson
(ben.sampson@markallengroup.com)

ASSISTANT EDITOR Paige Smith

SENIOR ART EDITOR Louise Green
DESIGN CONTRIBUTORS Andy Bass, Anna Davie, Julie Welby

PRODUCTION
Chloe Jeakins

CIRCULATION MANAGER
Charley Nash (circulation@markallengroup.com)

PUBLICATION DIRECTOR
Tom Eames (tom.eames@markallengroup.com)
PUBLICATION MANAGER
Jag Kambo (jag.kambo@markallengroup.com)

EDITORIAL DIRECTOR Tom Stone

PUBLISHER Simon Hughes
(simon.hughes@markallengroup.com)

COO Jon Benson
CEO Ben Allen
CHAIRMAN Mark Allen

MA Business
Part of Mark Allen
www.markallengroup.com

Aerospace Testing International (ISSN 1478-2774, PE 20657) is published 5 times a year in March, June, combined Aug/Sept, Oct and combined Dec/Jan by Mark Allen Group, Hawley Mill, Hawley Road, Dartford, Kent, DA2 7TJ, United Kingdom.
Tel: +44 (0)1322 221144
Email: aerospacetesting@markallengroup.com

Airfreight and mailing in the USA by agent named World Container Inc., c/o BBT 150- 15, 183rd St, Jamaica, NY 11413, USA. Periodicals postage paid at Brooklyn, NY 11256.
POSTMASTER: Send address changes to *Aerospace Testing International*, World Container Inc., c/o BBT 150-15, 183rd St, Jamaica, NY 11413, USA.

Subscription records are maintained at MA Business Ltd, Hawley Mill, Hawley Road, Dartford, Kent, DA2 7TJ, United Kingdom. Air Business Ltd is acting as our mailing agent.

© MA Business Ltd, 2025. All rights reserved. No part of *Aerospace Testing International* may be reproduced, stored in a retrieval system, or transmitted in any form or by any means electronic, mechanical, photocopying, recording, or otherwise without prior written permission of the publishing director. The views expressed do not necessarily represent those of the editor. The presence of advertisements in *Aerospace Testing International* implies no endorsement of the products or services offered. Every effort has been made to ensure the accuracy of statements in this magazine but we cannot accept responsibility for errors or omissions, or for matters arising from clerical or printers' errors, or an advertiser not completing their contract. We have made every effort to secure permission to use copyright material. Where material has been used inadvertently or we have been unable to trace the copyright owner, acknowledgement will be made in a future issue.

Please read our privacy policy by visiting **http://privacypolicy.markallengroup.com**.
This will explain how we process, use and safeguard your data.

Printed in the UK by Pensord Press Ltd, CF48 3TD.

MOVING ON?
If you change jobs or your company moves to a new location, please contact circulation@markallengroup.com to continue receiving your free copy of *Aerospace Testing International*

Average net circulation per issue for the period January 1, 2023 to December 31, 2023 was 10,159

COVER IMAGE: Sierra Space

Realize new testing possibilities...

Product Highlight A-CSS
PCM Serial and/or Ethernet
A-CSS

Advanced Correlating Source Selector

- State of the art data fusion combines telemetry data from multiple sources to generate optimal output with no missing or duplicated bits
- Automatically correlate and correct time skew between sources
- Dramatic improvement in data quality over individual sources
- Inputs and output via PCM signals or TMoIP

Learn more:

Powerful. Flexible. Rapidly reconfigurable and readily manageable.

NetAcquire telemetry data processing systems enable unprecedented flight and missile test architectures.

On the ground, at sea, or in the air, NetAcquire telemetry data processing capabilities are transforming what is possible.

Enter a new world of flight test mission capability and responsivity.

Farther, faster, better.

Call us today to see how we can help you do more on land, sea, and in the air.

NetAcquire®

www.netacquire.com
1-888-675-1122

WORLD *test update*

// EVIATION PAUSES ALICE ELECTRIC AIRCRAFT

Eviation has laid off most of its staff and ceased work on its Alice battery-electric aircraft as additional funding is sought to continue development.

The Arlington, USA-based company is ceasing operations and laying off staff to give it "time to explore strategic opportunities". Most staff at Eviation, which employed around 30 people, were laid off in early February.

Eviation's nine-seater Alice aircraft is targeted at the commuter and cargo markets and has been designed to have a top speed of 300mph (480km/h), a range of up to 250 miles (400km), and the capability to stay in the air for up to two hours.

Three variants were being developed, as well as the nine-passenger commuter version – a six-passenger executive version and a cargo version with a 2,500 lbs (1,100kg) maximum payload.

Eviation planned for the aircraft to start certification testing this year and to enter service by 2027.

Washington State, USA

// BUILD TO START ON ADAPTIVE CYCLE ENGINES

GE Aerospace and Pratt & Whitney have begun buying hardware for the US Air Force's Next-Generation Adaptive Propulsion (NGAP) program.

The two companies are developing their adaptive cycle engines for a generation 6 fighter jet engine and completed their proposals' detailed design review (DDR) last month.

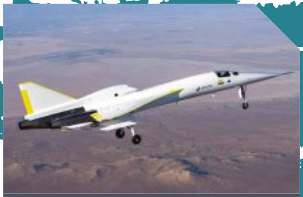
The DDR is a key milestone in the NGAP program, after which the US Air Force issues contracts to fund full-scale ground demonstrators. These are expected to be tested before the end of this decade.

Adaptive cycle engines can provide greater range and more thermal management capability compared to today's fighter jet engines. According to GE Aerospace gains of up to 30% are possible for range and thermal management compared to current generation fighter jets.

GE Aerospace's XA102 and Pratt & Whitney's XA103 engines will be the next evolution of the adaptive engine design and build upon the successful testing of the XA100 engine.

Both companies have heavily used digital modeling and simulation processes to develop the engine.

USA



// BOOM XB-1 FLIES SUPERSONIC

US company Boom Supersonic's XB-1 technology demonstrator aircraft reached a supersonic top speed of Mach 1.122 during its twelfth test flight in January.

XB-1 reached a top speed of 860mph (1,380km/h) at an altitude of 35,290ft during the 34 minute flight after it took off from the Mojave Air and Space Port in California at 08:31 am on January 28, 2025. The aircraft was flown by chief test pilot Tristan "Geppetto" Brandenburg and the flight path traversed the historic Bell X-1 Supersonic Corridor and the Black Mountain Supersonic Corridor over the Mojave Desert.

Boom Supersonic founder and CEO Blake Scholl said, "XB-1's supersonic flight demonstrates that passenger supersonic flight has arrived. A small band of engineers has accomplished what previously took governments and billions of dollars. Next, we are scaling up the technology on XB-1 for the Overture supersonic airliner. Our ultimate goal is to bring the benefits of supersonic flight to everyone."

Historically, supersonic aircraft have been developed using funding from governments and militaries. Boom Supersonic is claiming that XB-1's supersonic flight marks the first time an "independently developed" jet has broken the sound barrier.

XB-1 completed its first flight in March 2024 and has been progressing through a test flight program to expand its flight envelope. This involves flying under increasingly challenging conditions to evaluate systems and aerodynamics.

Colorado, USA

// DREAM CHASER PASSES CARGO-CARRY TESTS

The Dream Chaser spaceplane has shown it can carry cargo to the International Space Station (ISS) after passing a key testing campaign.

Joint Test 10B was run at NASA's Kennedy Space Center in Florida during January to prove the spaceplane can provide power, air-cool and exchange data with multiple payloads inside its pressurized cabin. These capabilities are needed to enable Dream Chaser to transport cargo to the ISS.

Dream Chaser is scheduled to make its first mission in May.

Pablo Gonzalez, vice president of crew and cargo transportation systems at Sierra Space said, "Tests like these are critical demonstrations of the capabilities of the Dream Chaser spaceplane and confirm our ability to handle specialized payloads.

"This milestone highlights Dream Chaser's flexibility and reliability, and brings us another step closer to launch."

Joint Test 10B test demonstrated that Dream Chaser can provide power within a specific voltage range and maintain the necessary environmental requirements for payloads. It also ensured all vehicle and payload data will be seen in Sierra Space's mission control room and in the payload support control rooms at NASA's Marshall Spaceflight Center (MSFC) in Huntsville, Alabama.

Florida, USA

// UK-SITE TO HOST FIRST ROCKET LAUNCH

The Civil Aviation Authority granted the first-ever vertical launch license for a rocket heading to space from UK soil to German company Rocket Factory Augsburg (RFA) in January.

The launch will see a 30m (100ft) tall RFA One rocket launch northwards from SaxaVord Spaceport in the Shetland Islands. RFA is planning for the first launch to happen this year.

Jörn Spurmann, co-founder and chief commercial officer of RFA said, "This is a groundbreaking moment for RFA and for Europe's space industry. Securing the first-ever launch license outside ESA's established site in Kourou marks Europe's bold step toward independent, competitive, and sustainable space access."

SaxaVord Spaceport became the UK's first licensed vertical launch spaceport last December and received its range control license in April 2024. Since then the CAA has been involved in an extensive program of monitoring the site.

The licensing process for RFA's launch looked at several key factors, including how safety is maintained, international obligations are met and environmental mitigations are made for RFA's proposed mission.

The license comes with pre-launch conditions, including ensuring international agreements with other countries are in place and that they have valid insurance.

Shetland Islands, UK

// EASA CERTIFIES ELECTRIC AIRCRAFT MOTOR

Last month, the European Union Aviation Safety Agency (EASA) certified Safran's Engineus 100 electric motor as an engine that complies with Special Condition SC E-19, the world's first Special Condition for electric and/or hybrid aircraft propulsion systems.

The first aircraft to use the Engineus will be Diamond Aircraft Industries' eDA40, an all-electric training aircraft.

1,500 hours of certification testing was performed on the motor and it accumulated more than 100 flight hours. Work on Engineus with EASA started eight years ago.

The Engineus 100 electric motor features power and control electronics integrated into the motor and an air cooling system. It delivers a maximum power of 125kW, with a weight-to-power ratio of 5kW/kg.

Safran plans to produce more than 1,000 Engineus motors a year by 2026, using four semi-automated production lines in Niort, France and Pitstone, UK. The lines will be equipped with space to increase production.

The initial B1 model which has been certified is suitable for installation on two-seater light aircraft. The aim is to extend the series to a greater power range of 89 KW to 180 KW, a baseline that would allow for wider applications in up to 19-seater regional transport aircraft.

According to Safran, the motor could also be used for the electric hybridization of future generations of commercial aircraft engines, capable of carrying 150 passengers.

Aircraft developers using the Safran motor also include Aura Aero, Bye Aerospace, CAE, Electra, TCab Tech, and VoltAero.

Niort, France

// DUBAI TEST RANGE TO HOST HAPS TESTING

UAE-based testing range Xrange is to host the flight test program for Mira Aerospace's high altitude platform station.

Xrange will serve as the primary Training, Testing, and Evaluation (TT&E) facility for Mira's ApusNeo HAPS platform, providing airspace allocation, ground-based trials instrumentation, and trials planning support.

Xrange is located 100km (62 miles) southwest of Abu Dhabi on a secure 355-square kilometer island and features co-located facilities, support services and expert personnel. The island enjoys favorable weather for year-round testing in assessing the performance of systems and platforms in hot, humid, and dusty conditions.

Mira is a subsidiary of UAE-based Space42. Its ApusNeo HAPS is a solar-powered aircraft designed to operate in the Earth's stratosphere.

Haitham Awinat, CEO of Xrange parent company Remaya said, "This cooperation demonstrates Xrange's commitment to supporting innovators and disruptors like Mira Aerospace by providing a full suite of range facilities and services to test and evaluate their solutions, accelerating their time to market."

Abu Dhabi, UAE

MIRA AEROSPACE
XRANGE
EDGE

For regular news updates:

AEROSPACETESTINGINTERNATIONAL.COM

777-9 VISITS CURAÇAO FOR HOT & HUMID TESTS

Boeing's 777-9 test aircraft WH002 has passed a series of flight tests in Curaçao in the Caribbean to assess its performance in tropical conditions.

The island's warm and humid climate of around 87°F (30°C) with 76.7% humidity is used by engineers to assess aircraft performance under high temperatures and moisture levels. These and flight tests in other parts of the world are required to ensure the 777-9 operates efficiently and reliably in different climates.

WH002 flew from Boeing Field near Seattle for 7 hours and 25 minutes before arriving at Curaçao on February 11, 2025. The 777-9 made eight flights while in Curaçao and returned to Boeing Field on February 24.

The US planemaker plans to complete FAA certification and deliver its first 777-9 next year.

Two variants of the 777X are planned. The 777-9 is Boeing's newest aircraft and is designed to seat more than 426 passengers. The 777-8 will provide seating for 395 passengers.

Boeing is working with a group of exclusive launch customers for the 777-9 and confirmed in an earnings call late last year that the first delivery will be to German airline Lufthansa.

Development of the 777X, which is powered by the GE9X, the largest and most powerful commercial jet engine in the world, started in 2011. The aircraft features several innovative features, most notably folding wingtips so it can fit into standard airport gates.

Boeing said, "We continue to execute a rigorous test program to demonstrate the safety, performance and reliability of the 777-9 and are working toward first delivery in 2026.

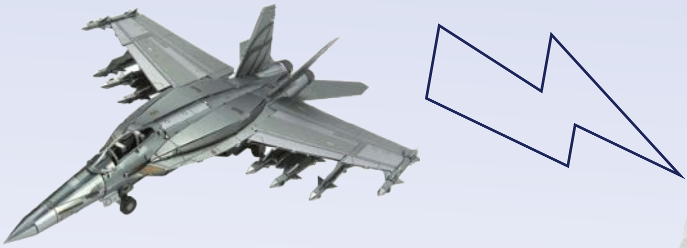
"Our team has now put the 777-9 test fleet through more than 1,300 flights and 3,700 flight hours across a range of regions and climate conditions."

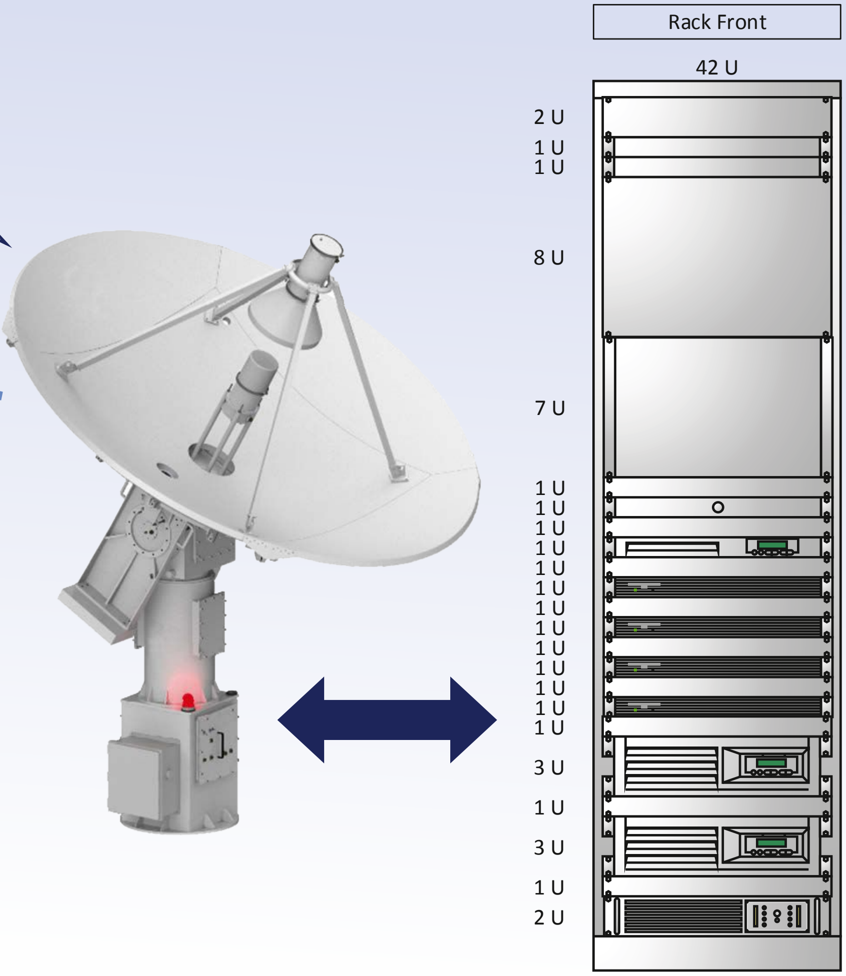
The development of the 777X has suffered setbacks and delays. The aircraft's original entry-into-service was planned for 2020, but first flight was delayed a year to 2020 because of issues with the GE9X. Problems were also found during stress testing on the ground in 2019 when a door blew off during a pressurization test. \\

// Boeing's 777-9 test aircraft WH002 is performing climate flight tests around the world, including at Curaçao in the Caribbean

For regular news updates:
AEROSPACETESTINGINTERNATIONAL.COM

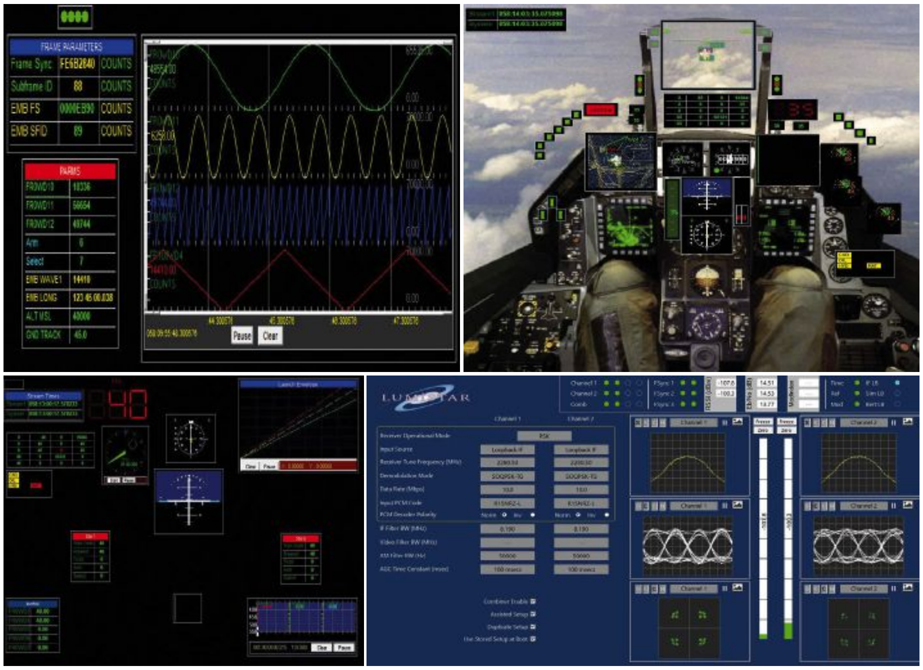
TELEMETRY GROUND STATIONS
From Lumistar




Rack Front
42 U
2 U
1 U
1 U
8 U
7 U
1 U
1 U
1 U
1 U
1 U
1 U
1 U
1 U
1 U
1 U
1 U
1 U
1 U
3 U
1 U
3 U
1 U
2 U

Partner with Lumistar for your next Telemetry System

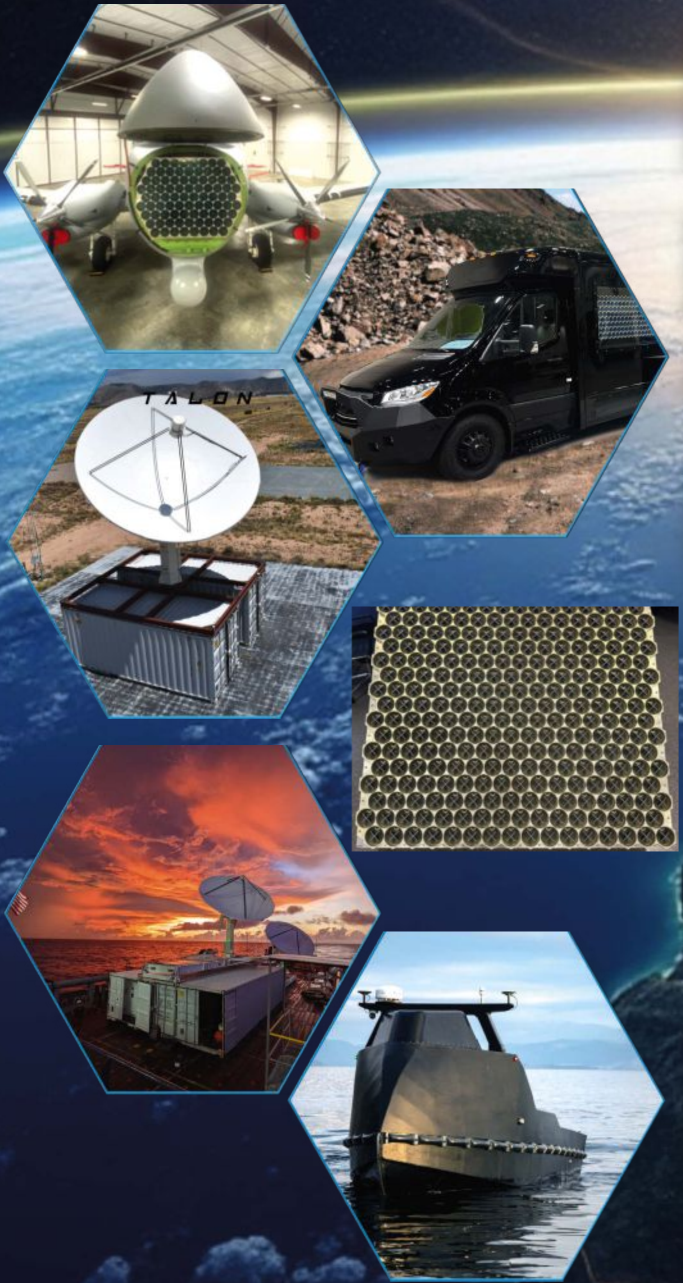
- Fixed and Mobile Systems
- End to End Hardware Solution
- Application Tailored Designs
- Real Time Display Software
- Subject Matter Expertise
- Requirements Development
- Tracking Antenna Subsystems
- Receivers/Demods
- Network Telemetry
- Data and Rf Recording
- Simulation Tools
- Remote Solutions
- Automated Maintenance Checks
- Customer Training & Support
- Logistics Planning
- Site Surveys



sales@lumistar.net www.lumistar.net

RAVEN DEFENSE

RANGE COVERING REQUIRES RAVEN.



RAPTR: *The Raven Advanced Phased-array Telemetry Resource is the most versatile and flexible commercially available antenna on the market. It is modular and scalable, and can integrate back-end telemetry equipment into a single package.*

RAPTR is the ideal solution for airborne platforms due to its superior SWaP-C attributes and lack of moving parts. It is also attractive for land or maritime applications for tests involving multiple targets.

S-band standard 2200 MHz - 2400 MHz
  L, L/S, and C options available
  ~1.5 dB/K G/T (64-e module)
Dual polarized
8-Beam standard
1 FOV full spectrum scanning beam
7 independent dual polarized data beams
Custom beam counts available
Hybrid phased array
Full 200 MHz S-Band bandwidth/beam
3.2 GHz beam-bandwidth product
+/- 45 degree FOV in AZ and EL
Fast-scanning, 3kHz scan rate
Low SWAP
  ~150W power draw per 64-e module
  ~250W for control and monitoring
  ~100 lbs/module
Compact form factor
Single module ~30"W, 28"H, 6"D
Affordable, high performance, quick turn
FULLY EXPORTABLE!
  Classified EAR99 – no license required
  Designated 5A991.g

RAVEN DEFENSE CORPORATION - 4411 The 25 Way NE, Suite 200, Albuquerque, NM 87109
info@ravendefense.com (505) 587-3010 RavenDefense.com LinkedIn.com/Company/Raven-Defense

FIND MORE DETAILS ON HAPS TESTING ON PG56

// The Zephyr HAPS has made its maiden flight from its new base in Kenya

ZEPHYR HAPS MOVES OUT OF AFRICA

Airbus subsidiary Aalto HAPS ran the first successful stratospheric flight test of its Zephyr aircraft from a purpose-built facility in Laikipia County, Kenya last month.

The Zephyr, which has a 25m wingspan and weighs 75kg (165lbs) is a High Altitude Platform Station (HAPS). The aircraft has been in development at Airbus since 2013. The program was originally started by UK-based defense company QinetiQ in 2003.

Aalto is targeting applications including surveillance, disaster management, border protection, and agriculture for Zephyr, although its first customers are likely to be in the defense sector.

Zephyr flew for more than 13 days at altitudes above 60,000ft during the first Kenyan flight, safely taking off and landing from Aalto's facility, which the company is calling an Aaltoport.

The remotely-controlled drone was equipped with a payload developed at Aalto's Farnborough, UK headquarters that can provide direct-to-device 4/5G connectivity. Compatible with smartphone technology to enable video and data services, Aalto conducted tests to characterize the performance of the connectivity system.

During the flight, Aalto also validated improvements to Zephyr's flight envelope that provide greater stability and performance.

Aalto secured permissions to establish an Aaltoport for stratospheric operations during 2024, following 18 months of regulatory engagement and technical studies to facilitate flight approvals.

Hughes Boulnois, CEO of Aalto, said, "Zephyr's return to stratospheric testing and operations is an important step in its commercial roadmap. Stewarding the most established platform globally, Aalto is demonstrating the capabilities of Zephyr from a payload and platform perspective.

"With unrivaled performance and flexibility and being a payload agnostic platform, our Zephyr is a complementary asset to traditional space and defense ecosystems."

Brigadier Hillary B Kipkosgey, acting director general / CEO of the Kenya Space Agency, said, "HAPS is a unique capability with potential use cases that Kenya recognizes as critical to many stakeholders.

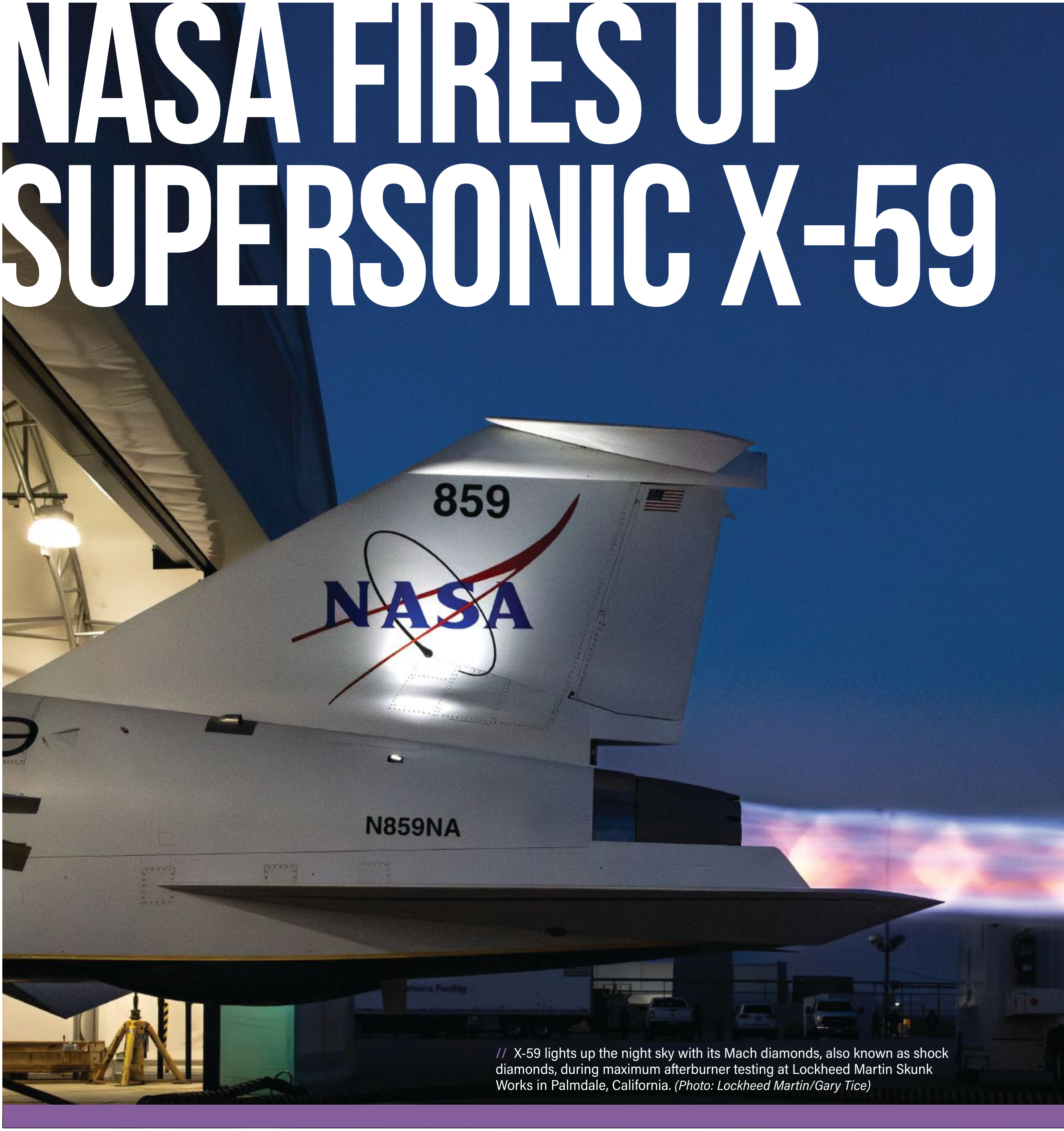
"Through our support to Aalto, we are pleased to demonstrate Kenya's global leadership in creating a new hub for near space technology."

Zephyr's current flight-time record is more than 64 days in the stratosphere. \\

For regular news updates:

AEROSPACETESTINGINTERNATIONAL.COM

NASA FIRES UP SUPERSONIC X-59



// X-59 lights up the night sky with its Mach diamonds, also known as shock diamonds, during maximum afterburner testing at Lockheed Martin Skunk Works in Palmdale, California. *(Photo: Lockheed Martin/Gary Tice)*

// Test pilot Jim Less exits the cockpit of the X-59 aircraft in between EMI testing *(NASA/Carla Thomas)*

NASA's X-59 Quesst quiet supersonic research aircraft has passed key engine and electromagnetic testing programs before its planned first flight later this year.

Data from the test flights will help establish an acceptable noise standard for commercial supersonic flights over land, lifting a 50-year ban.

This will be a vital regulatory step for companies such as USA-based Boom, which is developing a commercial supersonic passenger aircraft.

ENGINE TESTS

The modified F414-GE-100 engine performed to expectations during the three increasingly complicated tests which were ran between October and January at main contractor Lockheed Martin's Skunk Works facility in Palmdale, California.

Raymond Castner, X-59 propulsion lead at NASA's Glenn Research Center said, "We had no showstoppers. We were getting smooth and steady airflow as predicted from the wind tunnel testing. We didn't have any structural or excessive vibration issues. And parts of the engine and aircraft that needed cooling were getting it."

The tests began with assessing how the aircraft's hydraulics, electrical and environmental control systems performed when the engine was powered up but idling. Engineers then performed throttle checks, bringing the aircraft up to full power and firing its afterburner.

A third test, throttle snaps involved moving the throttle swiftly back and forth to validate that the engine responds instantly. X-59's engine produces as much as 22,000 lbs of thrust to achieve the desired cruising speed of Mach 1.4 (925mph) at an altitude of 55,000ft.

The F414-GE-100 engine, which is also used in the US Navy's F-18 Super Hornet is mounted on top of the aircraft to reduce the level of noise reaching the ground. The X-59's 38ft-long nose will also lower the noise of sonic booms to a "thump," similar to the sound of a car door slamming nearby.

ELECTROMAGNETIC TESTING

Following the engine tests, electromagnetic testing was carried out to examine the X-59's internal electronic systems. These tests confirmed that the X-59's systems such as radios, navigation equipment and sensors can work together safely, without interference from each other or external sources disrupting critical systems.

Yohan Lin, NASA's X-59 avionics lead said, "Reaching this phase shows that aircraft integration is advancing. It's exciting to see the progress, knowing we've cleared a major hurdle that moves us closer to X-59's first flight."

The electromagnetic interference (EMI) tests were also conducted at the Skunk Works' facility. During the tests, engineers activated each system on the aircraft one at a time while they monitored the other systems for possible interference.

"This testing helped us determine whether the systems within the X-59 are interfering with each other. It's called a source-victim test – essentially, we activate one system and monitor the other for issues like noise, glitches, faults, or errors," said Lin.

The X-59 is the centerpiece of NASA's Quesst mission and is progressing steadily through ground tests to ensure safety and performance.

Other electromagnetic interference testing involved the team looking at the operation of the X-59's landing gear, ensuring this critical component can extend and retract without affecting other systems. Engineers also tested that the fuel switch shutoff was functioning properly without interference.

To ensure the X-59's systems will function properly when it eventually flies near other NASA research aircraft, researchers staged the X-59 on the ground in front of NASA's F-15D, placing them 47ft (14m) apart, then 500ft (150m) apart. The proximity of the two aircraft replicated conditions needed for the F-15D to use a special probe to gather measurements about the shock waves the X-59 will produce.

"We want to confirm there's compatibility between the two aircraft, even at close proximity," Lin said.

For the tests the team powered up the X-59's engine while turning on the F-15D's radar, C-band radar transponder, and radios. Data from the X-59 were transmitted to NASA's mobile operations facility, where control room staff and engineers monitored for anomalies.

"You want to make discoveries of any potential electromagnetic interference or electromagnetic compatibility issues on the ground first," Lin said. "This reduces risk and ensures we're not learning about problems in the air."

The next stage of testing for X-59 will be aluminum bird tests, during which data will be fed to the aircraft on the ground under both normal and failure conditions and then taxi tests before flight. \\

// The F-15D research aircraft is next to the X-59 during electromagnetic compatibility testing US Air Force Plant 42 in Palmdale, California *(NASA/Carla Thomas)*

TESTING TO HELP STOP RUNWAY OVERRUNS

An unusual test campaign is helping regulators understand how wet runways impact landing aircraft, writes Gerard Van Es, Principal Advisor of Flight Safety and Operations at NLR

PH-LAB
nlr
25-7

Worldwide, there are at least two landings every week where aircraft fail to stop on the runway in time. Sometimes pilots cannot slow down sufficiently, but there can also be problems with the runway.

Wet runways are clearly a contributing factor, but exactly what causes an aircraft to slip during landing is very complex with many factors involved. The €1.5 million Runway Micro Texture Project, which involved the Dutch aerospace research agency NLR and the German research centre DLR was run over the last three years for EASA to solve this and improve the understanding and safety of aircraft landings.

Initial studies found that the braking performance of aircraft on wet runways was often much worse than assumed. Most runways are made of asphalt or a similar product. While the crushed stone in asphalt provides drainage, the small, sharp pieces similar to sandpaper provide a runway's micro-texture and friction.

Sufficient micro-texture is essential for good braking performance when a runway is wet. When a micro-texture wears down a runway becomes more slippery. Airports struggle to determine the level of this wear.

In addition, current requirements are based on measurements of runway macro-texture – its visible surface roughness – using methods such as the sand and grease patch and runway friction testers. Measurements made with runway friction testers suffer from uncertainty and errors. This has resulted in overestimating the braking capabilities of a runway under wet conditions. In some ways, determining aircraft friction is more like an art than a science.

A flight test program was planned and carried out to collect aircraft wheel-breaking friction data from wet runways as part of an EASA-sponsored research project funded by the European Union's Horizon Europe research and innovation program. The biggest challenge of the program was that the runways had to be soaked to recreate rainfall.

The testing used NLR's Cessna Citation 550 and DLR's Falcon 2000 (ISTAR). Large commercial aircraft were avoided because they are expensive, in demand and cannot operate at smaller airports – the runways used had to be closed during the tests.

Testing took place at Twente in the Netherlands, Cochstedt and Braunschweig-Wolfsburg in Germany and NASA Wallops in the USA.

For the tests, a section of the runway was wetted to a specified level using trucks carrying 36,000 liters (9,500 gallons) of water. The aircraft was put in a fixed position with the engine idling. Runs were done to the aircraft's maximum braking. The aircraft was vacated and the brakes were allowed to cool before inspection.

Each run required around up to 8,000 liters of water to be dropped. At NASA Wallops we used about 15,000 litres (4,000) gallons of water and dams to increase the water depth.

While each run took only a few seconds, they cost hundreds of thousands of euros each. The runs had to be done quickly because runways are designed to drain water away.

> “WHILE EACH RUN TOOK ONLY A FEW SECONDS, THEY COST HUNDREDS OF THOUSANDS OF EUROS EACH”

Data from the tests has been used to determine the effective brake friction at different speeds. If an airport knows what texture their runways have, they can inform the pilots of the correct braking characteristics of the runway. This allows us to increase the chances of a successful landing.

Within the EASA Runway Micro Texture program, NLR is now developing a method by which airports in Europe can map their own runways very precisely by using advanced lasers. The FAA is also interested in the results and has asked NLR to conduct additional flight tests. \\

961-998e-02.25

RELIABLE MEASUREMENT SOLUTIONS FOR THE SPACE INDUSTRY

From earth to space: Your trusted partner for precise measurement at every stage of your space program.

www.kistler.com/aerospace

Scan the QR code
for more information

KISTLER
measure. analyze. innovate.

---

datatel
TELEMETRY

ROTATING INSTRUMENTATION SOLUTIONS FOR AEROSPACE TESTING

Customized. Efficient. Reliable.

Wireless telemetry solutions for testing of rotating components, eg. in turbofan and turboprop engines, eMotors, propellers, helicopter main and tail rotors, wind tunnel model propulsion, rocket turbo pumps, aero engine bearings and seals, reduction gearboxes, APUs etc.

High performance telemetry systems with outstanding reliability for use in applications under most severe operating conditions. Suitable for R&D, component test rigs or flight testing. Application engineering capability for customized turnkey solutions.

Website

LinkedIn

sales@datatel-telemetry.de
www.datatel-telemetry.com

// PAUL E EDEN

Groun
brea

G400
N400G
Gulfstream

d king

// The G400 during its first flight on 15 August 2024

20 years since it opened, Gulfstream's R&D campus works at the forefront of developmental and certification testing

Gulfstream flew its latest model, the G400, for the first time on August 15, 2024. The aircraft lifted off from Savannah/Hilton Head International Airport and completed a 2-hour 54-minute sortie before landing back. And so another next-generation Gulfstream model, the fifth in ten years, entered flight test, backed by the company's R&D Center and Labs campus. Opened in 2006, the facility includes flight test laboratories and today encompasses more than 600,000 square foot while employing approximately 2,600 innovation and engineering professionals.

Vicki Britt, senior vice president, innovation, engineering and flight at Gulfstream, says, "The flight test labs Gulfstream uses today were developed for the next-generation Gulfstream fleet, which began with the G500 and G600, and now includes the G700, G800 and G400.

"The flight test labs include flight deck and cabin integration test facilities to develop and mature the integration of electronic system wiring and hardware and software – the iron bird, which tests flight control and mechanical systems, a conceptual advanced simulation environment to develop flight deck layouts and fly-by-wire control laws and conduct human factors evaluations. The labs also include a systems integration bench, which integrates avionics and aircraft systems with the aircraft's data concentration network."

The campus focuses on two primary areas beyond new aircraft programs. The labs continue their support to in-service aircraft as technology updates and new developments emerge and are tested before reaching the fleet, and they create and test future innovations. Facilitating all of this, the R&D campus includes facilities dedicated to acoustics and structural testing, extended reality, rapid prototype and additive manufacturing technologies, manufacturing techniques

VICKI BRITT, SENIOR VICE PRESIDENT, INNOVATION, ENGINEERING AND FLIGHT AT GULFSTREAM

Vicki Britt's career embodies the aims of Gulfstream's Research and Development Center and Labs campus. With a PhD in aerospace engineering from Old Dominion University, and an MSc in mechanical engineering and BSc in aerospace engineering from North Carolina State University, Britt began her aerospace career at NASA's Langley Research Center in Hampton, Virginia.

She joined Gulfstream in 1996 and subsequently worked in stress, fatigue and damage tolerance, new product development and airframe engineering. Britt also served as staff scientist and director of aircraft structures, and chief engineer and program manager of Gulfstream special missions, before being appointed senior vice president of innovation, engineering and flight in May 2021.

Since then, Britt has taken responsibility for research and development, new aircraft program initiation, engineering and product development, flight, lab and structural test, and worldwide Gulfstream flight operations.

and technologies, environmental control systems, and advanced materials, plus the flight-test labs where aircraft undergo ground testing for development and certification.

BEYOND REQUIREMENTS

Within the R&D environment, some lab elements would be familiar to past generations of aircraft engineers, including the fatigue test rigs. That familiarity might be superficial because Gulfstream goes one step beyond. Britt explains, "Like all aircraft manufacturers, Gulfstream performs full-scale fatigue tests to verify structural fatigue lives, validate structural inspection programs and ensure the safety of all passengers and crew. These trials begin before type certification to support entry into service and then continue for several years until completion.

"The aircraft structural inspection program – inspection locations, intervals and techniques – is determined by analysis, and computer modeling and provides a critical link between real-world test results and the data and assumptions used in the analysis. Digital twins of the fatigue test aircraft are used to understand the test results better and provide additional fidelity in the resulting analyses; strain gauge results from the test aircraft, for example, are directly correlated to stress levels in the digital twin. Additionally, periodic data reviews from our fleet ensure that the assumptions made in our test loading continue to be valid."

Every new Gulfstream model is certified to FAA, EASA and other standards as customers in new regions emerge. Testing for compliance is expensive yet as far as regulation is concerned, Gulfstream goes well beyond the work required for certification. Britt responds to the question of why that additional investment is deemed worthwhile: "It's part of our mission to pursue the utmost in safety and exceed expectations. By testing beyond requirements, we know that our aircraft can be certified to meet those requirements with absolute confidence and do so with an abundance of safety.

"Testing beyond requirements has also at times revealed that our aircraft perform beyond the initial estimates. The G500, G600 and G700, for example, demonstrated better performance in testing than we originally expected, and all of them were certified with longer range capabilities than when they were announced, to the great benefit of our customers."

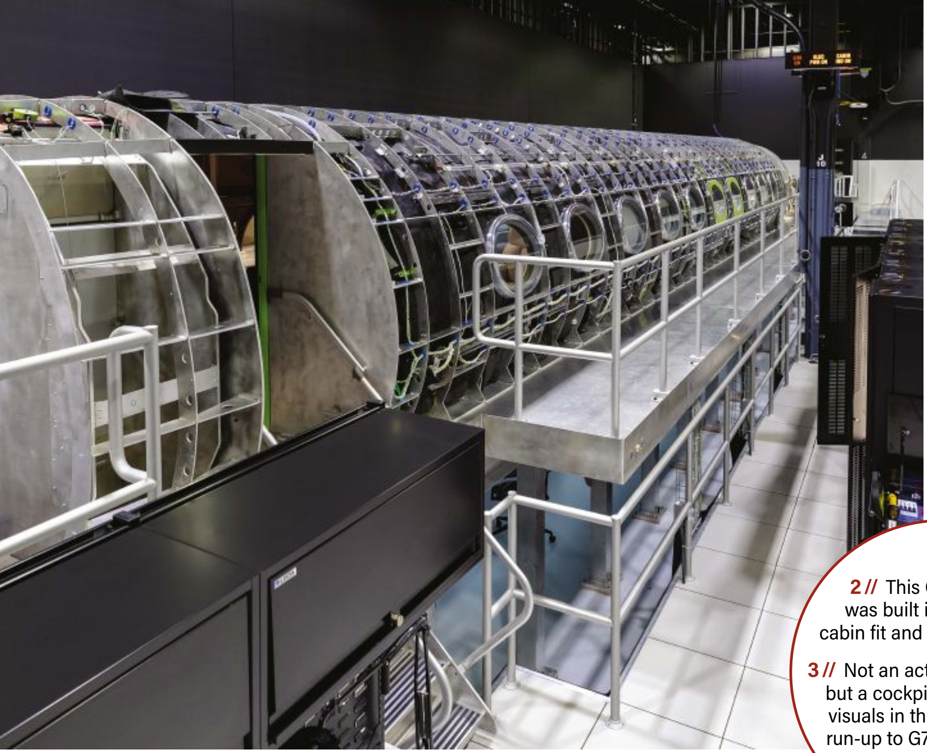
> ***"Testing beyond requirements has revealed that our aircraft often perform better than originally expected"***

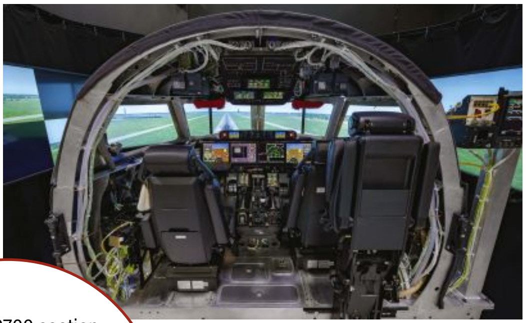
To those customers, and the world at large, every aircraft emerging from Savannah is simply a Gulfstream, yet each includes components large and small provided by other manufacturers. From an engine OEM delivering a complete integrated engine and nacelle, through to an avionics supplier building a flight deck and a cabinet maker supplying a cabinet door, all must meet Gulfstream's exacting standards, adding to its test load.

Britt explains, "We work closely with suppliers to ensure their products meet our exacting standards and also have key supplier engineers embedded with our teams when necessary in the testing phase. In the labs, we can test and validate the functionality of software coming from suppliers and test all aircraft systems before first flight. We also create many components in-house – including cabinetry and furnishings, wings and nacelles for some models, giving us even more quality control and allowing us to integrate many of these elements into the testing phase."

Britt mentions aircraft systems testing and Gulfstream is far from unique in the extent of testing it performs leading up to first flight. By the time a new

1 // The G600 iron bird demonstrates the size and complexity of these essential trials tools





2 // This G700 section was built in the labs for cabin fit and other trials work

3 // Not an actual G700 cockpit, but a cockpit simulator, with visuals in the test lab in the run-up to G700 certification

> ***"By the time a new aircraft's wheels leave the runway on its maiden flight, it has already undergone thousands of hours of testing"***

> **“Gulfstream’s R&D campus is where innovations are tested before they ever reach the fleet”**

aircraft’s wheels leave the runway on its maiden sortie it has already gone through thousands of testing hours as an iron bird, on a computer and in the simulator.

“Extensive ground testing in the labs makes a first flight even safer and more successful,” says Britt. “In the labs, we can amass thousands of simulated flight hours before the aircraft leaves the ground, ensuring the systems, including avionics and environmental controls, work as they should, and we can further optimize those systems in the labs before first flight. The lab testing also enhances efficiencies because we can achieve certification test points on the ground.”

The first flight is therefore largely a verification exercise compared to the exploratory nature of historic debuts. Does that mean the magic of achieving the first flight has been lost? Britt says not, while emphasizing that it also marks the end of one testing phase and the beginning of another in the labs.

“Making a first flight on a new aircraft is an exciting moment that instills pride in the team on the program and throughout the entire company,” she says. “Once flight test is underway, testing in the lab continues to help drive the efficiency of test flights – we can fly in the morning, analyze the data in the labs and make necessary updates the same day.”

FASTER AND SAFER

Due in no small part to its R&D efforts, today’s Gulfstream models are faster, more efficient, and safer than the aircraft they replace. While acknowledging the important role that the labs play in trialing new technology for in-service aircraft, Britt confirms that continuous improvement is a top priority, with teams dedicated to future technologies and safety advancements.

She illustrates the point by explaining the labs’ role in previous technology insertions: “Gulfstream’s enhanced flight vision system [EFVS] is just one example. We continue to enhance our EFVS system, which was first introduced on the GV. With the G500 and G600,

4 // Gulfstream announced the G600 iron bird’s ‘first flight’ on 23 February 2016. This is the cockpit from that maiden mission

5 // Testing underway on the G500 cockpit using a simulated flight

PFI

50 1975-2025 Celebrating half a century of excellence

Precision Filters ■ Signal Conditioning ■ Data Acquisition Systems

Measure With Confidence

Best-in-class signal conditioning and modern DAQ in a fully integrated system

Verify Performance

Built-in self-test and calibration capabilities that are unmatched in the industry

Collect Data You Can Trust
PRECISION FILTERS, INC.
Data Acquisition System
SDAS16

Learn from Experts

Comprehensive knowledge base and technical support from PFI engineers

www.pfinc.com

Design with Us

Engineered turnkey solutions with custom cabinets, cabling, and I/O panels

sales@pfinc.com

7 // A G700 cockpit avionics test bench set up for a test

6 // Exhaustive lab testing removes doubt out of the first flight and supports aircraft evolution during certification and into service

> ***"Our labs amass thousands of simulated flight hours to optimize aircraft systems before first flight"***

Gulfstream was the first original equipment manufacturer to earn FAA certification allowing operators to use EFVS to dispatch and begin instrument approaches in low-visibility conditions.

"We then obtained the same certification for additional in-production and out-of-production aircraft so our customers could take advantage of this safety enhancement.

"For the G700 and G800, we took our flight deck innovations even further, adding our combined vision system [CVS] on dual head-up displays [HUD]. With the CVS, Gulfstream's EFVS and synthetic vision system are overlain on the HUD, providing enhanced pilot situational awareness. The labs have been instrumental in our efforts to enhance this technology."

A handful of forward thinkers see the relationship of the business aviation niche to the wider aviation industry as akin to that of Formula 1 to the automotive industry. Safety enhancements, like the HUD technology Britt is so proud of, typically first find their commercial application in business jet cockpits, while business jet owners and operators were early adopters of sustainable aviation fuel. This pioneering spirit relies upon a mix of practical engineering and blue-sky thinking, where OEMs accept that at least some of their R&D budget must be spent allowing the imaginations of designers and engineers to visit places yet unknown.

It is a philosophy Gulfstream embraces. Britt reveals, "We always have engineering teams dedicated to researching new and future developments, and they work hand-in-hand with the engineers working on current aircraft design, industrial design and flight deck systems.

"Thanks to General Dynamics, Gulfstream's parent company, the investments we have been able to make in R&D have led us to create what we consider to be the most advanced fleet in the industry."

People are the key element in R&D and labs like Gulfstream's require a mix of experienced heads and new thinking. In an era where suitably equipped and qualified personnel are difficult to find and equally tricky to retain, how does Gulfstream staff a Research and Development Center and Labs campus that requires engineers with decades of experience and graduates with heads full of new ideas?

Confirming this approach, Britt continues: "We have engineers who have been with the company for decades and others who have just joined us.

"We attract many new engineers through our extensive internship and co-op programmes, which bring students from around the world. We also actively recruit across college campuses and military bases.

"We value the perspectives our diverse group of engineers brings and believe they have a positive impact on Gulfstream's culture of innovation." \\

YOUR PARTNER IN SIMULATION AND VALIDATION

dSPACE

Safety Through Validation.

Aerospace engineers fulfill the highest standards when it comes to verification and validation. Reliability is essential – no errors. dSPACE real-time simulators help increase your test coverage and eliminate defects as early as possible in your development process. Long-term availability of our hardware and software tools gives you the assurance you need to achieve your goals. Start shaping the future now. **aerospace.dspace.com**

// BEN SAMPSON

Fit &

// CAE engineers carry out visual assessments of the pilot's position using this Piper Archer fuselage to assess how changes for the electric conversion will impact flying the aircraft

fly

A pioneering project to decarbonize its fleet of aircraft is taking a Canadian training company into the world of electric aviation

Piper
ARCHER TX
GRAINGER

Tucked away on the edge of aviation training provider CAE's campus in Montreal, Canada is a laboratory containing a surprising side-project for a company best known for making flight simulators.

Visiting this laboratory is not a straightforward proposition. It requires a guide. The route takes in several office floors, through back-of-building fire exits and down bare-brick stairwells.

Upon arrival, the visitor is greeted by the sight of several Piper Archer light aircraft in various states of undress in two large rooms. There are fuselages and wings, test rigs, racks of lithium-ion batteries and a motor. There are test benches littered with avionics boxes and cables, and about a dozen engineers hard at work in an adjacent room with the blinds down.

The team here has been working on a project to convert the four-seater Piper Archer trainer to battery-electric propulsion since 2022. CAE runs several pilot academies around the world and has more Piper Archers, around 60, than other type of aircraft in its fleet. Most are based at its FBO in Phoenix, Arizona. By electrifying training aircraft, the company hopes to reduce its carbon emissions and reduce operating costs. It will also plans to sell the certified conversion kit to the wider market.

> **"Once the aircraft is inside we will remove the engine"**
>
> **MUKUND PATEL, DESIGN LEAD ELECTRIC AIRCRAFT, CAE**

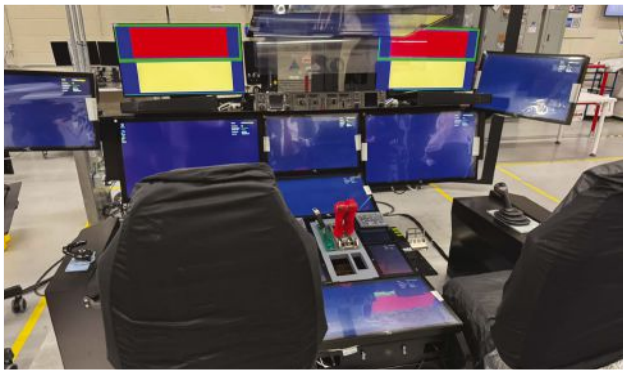
REMOVE & REPLACE

The program is in the detailed design stage and last year passed the preliminary design review. The next big milestone is the delivery of the first flight test vehicle within the coming months.

"Once the aircraft is inside we will remove the combustion engine and everything else we don't need. We are installing some of the batteries in the wings – their structure is being modified – and some behind the pilot by removing the rear seats," says Mukund Patel, design lead for electric aircraft at CAE. "We will then install the new engine, a new propeller and cowling and integrate all the other components."

The experimental aircraft uses a Safran Engineus motor. The team has a motor for testing purposes and recently attached this to a pressure drop rig to assess its flight performance. The team also performed testing at NRC (National Research Canada) facilities. Engine testing started in the Summer of 2023. "We simplified NRC's setup to our needs, so we can test different iterations of the design quickly," says Patel.

In the pressure drop rig, room air is compressed and



1 // CAE's factory in Montreal, Canada produces its range of flight simulators, from the full motion 7000RX series for flight training to the 400RX used for cockpit familiarization

SIMULATOR MANUFACTURING

All CAE simulators are made at the one million square foot plant and head office in Montreal, Canada. The plant has 550 employees that work four shifts and is divided into four areas: fabrication, logistics and shipping. Production runs along a long straight line – fabrication is done on the left had side and assembly on the right.

Around two full flight simulators are produced each week. Depending on the unit and customer, a simulator takes between 35 and 40 days to make. Each simulator spends about a week at a station before it arrives at testing and logistics to be shipped. Testing is done at the module level and the whole unit level to speed the process up.

About 10 years ago, the range of simulators was consolidated into one – the 7000RX series and the design modularized into five main parts to improve manufacturing efficiency. Although externally they look almost identical, inside the cockpits they are very different, and the software varies.

One of the most complex modules to assemble is for the flight controls. The flight module is also the final part of assembly and is "dropped" into the simulator. Testing of the electrical connections, data interfaces and software is then carried out. The site has 19 test stations and another 19 in a separate building.

The factory produces some 7000RX variants at high volume, A320s or 737s for example. It also makes limited prototype runs, as well as helicopter simulators such as the 3000 series in lesser amounts.

"Splitting high volume and prototype helped us increase production efficiency considerably," says Steve Levesque, vice president of global hardware engineering and quality assurance.

Unusually, the manufacturing supply chain is vertically integrated to enable management to reduce dependency on suppliers and control over rate. The simulators are designed onsite, and the company even produces its own PCBs. "We had challenges in the past with lead time and quality," says Levesque.

Photron

HIGH-SPEED CAMERAS FOR SLOW MOTION ANALYSIS

Photron
nova
Photron
PHARSIGHTED

High-speed cameras are used in a variety of applications to capture fast processes that would be otherwise invisible to the human eye. Photron high-speed cameras are used for research and testing in many different industrial, scientific, medical and military applications.

Ultra High-Speed Cameras

640 x 480 pixels at 326,000fps
Reduced resolution to 2.720Mfps
Light sensitivity to ISO 160,000
Minimum exposure to 0.059µs
Internal memory to 432GB
Removable SSD
High-speed 1/10-Gigabit Ethernet Interface

High-Speed Cameras

1 Megapixel resolution to 20,000fps
Reduced resolution to 1.100Mfps
Light sensitivity to ISO 64,000
Minimum exposure to 0.2µs
Internal memory to 128GB
Removable SSD
High-speed 1/10-Gigabit Ethernet Interface

High Resolution Cameras

4096 x 2304 pixels 4K at 1,250fps
3840 x 2160 pixels UHD at 1,440fps
Light sensitivity to ISO 4,000
Minimum exposure to 2µs
Internal memory to 128GB
Removable SSD
High-speed 1/10-Gigabit Ethernet Interface

Photron
www.photron.com image@photron.com

fed across different parts of the motor. Pressure probes measure the pressure drop across the parts. "The data from the rig is closer to real life and allows us to see if our safety analysis is right," Patel says.

Behind the pressure rig in the laboratory is an electrical systems mock-up being used for functional testing, consisting mainly of two racks of lithium-ion batteries supplied by Switzerland-based company H55. The racks are independent and represent the two halves of the battery pack, supplying current through the power distribution with the low voltage networks and DC/DC converter.

The same Engineus motor is used for both electrical and mechanical testing. "We are testing all our safety cases and that the electrical integration is up to par," says Patel.

ACCESS ISSUES

Behind the electrical test bed is a semi-dismantled Archer fuselage being used to test the fit of parts and connections. Richard Alexander, aircraft integrator at CAE says, "We use it for testing concepts, to find out how new parts are going to fit and affect the aircraft. For example, battery packs are going where the rear seats were, and we are switching like-for-like in terms of weight. We also look at things like the seatbelts, the access, where to put buttons and displays, and what circuit breakers we need to replace.

"The biggest effort is probably the installation of the batteries, which is complex because they are distributed. There is an air distribution system that cools the batteries while they are charging. We also have to think about thermal runaway and containment."

The CAE team has designed a removable leading edge and battery casings for the wing batteries so the cells can be replaced when they age. "We are taking the fuel tanks out of the wing and putting batteries in. There will be some additional structure to support those modules," says Patel. "We use 3D printing to modify the physical mock-ups."

Testing the energy system and the cockpit displays typify the challenge the team face around developing the conversion kit before the regulations for battery-electric aircraft are finalized.

Existing regulations are written for fuel that burns, not batteries that supply electricity. Aspects of the design such as which parameters concerning the battery and propulsion system must be displayed by the avionics is still being decided.

The regulatory approach for thermal runaway is also yet to be determined. When it is, it will have a massive factor on the detailed design for the battery's integration into the aircraft.

"There isn't a frozen framework for certification so any change can influence things," Alexander says, "95% of the regulations are fixed, but that last 5% affects the other 95% and how you approach the overall design."

2 // The CAE Montreal site is arranged around a central production line for the simulators

> **"We need the right parts before we can fly"**
>
> **STELLA FILIPPATOS, DIRECTOR OF PROGRAM MANAGEMENT – ELECTRIC AIRCRAFT, CAE**

PARTS OF THE PROBLEM

According to Stella Filippatos, director of program management – electric aircraft, CAE, the fluid regulatory framework for electric propulsion is one of the biggest challenges the team faces.

She says, "It's very difficult to meet regulatory requirements that haven't been written yet.

"eVTOL has gained a lot of attention over the last few years, but these aircraft will be flying before eVTOLs. Regulators' focus is beginning to be redirected onto Part 23, so they can become operational sooner."

An associated challenge is around the supply chain for parts. "There is no volume production, so you are either waiting for parts or tailoring them to fit, in which case you are constrained by the geometry of the aircraft," Filippatos says.

"We need the right parts to fly. The battery packs and motor we are using for testing are experimental and won't be used in the final aircraft."

UNDER THE FUSELAGE

The project isn't all pioneering steps into the unknown. The Archer first flew in 1960. Piper as the OEM is providing support and know-how. Alexander says, "How the Archer operates

The world's only event dedicated to aerospace testing and development

Aerospace TEST& DEVELOPMENT SHOW

30 September – 1 October 2025

MEETT, Toulouse, France

120+ exhibitors expected

www.AeroTestDevelopmentShow.com

To book your participation, contact either
Tom Eames, Executive Brand Manager, tom.eames@markallengroup.com, **or**
James Howson, event manager, james.howson@markallengroup.com

What will be on display?

- Complete aircraft testing systems and services
- eVTOL testing and development tools
- Passenger drone and UAV testing and development
- Air-defence system test and validation
- Alternative propulsion and next-generation power-source test and development, systems and services
- Testing systems for supersonic and hypersonic aviation
- Durability and accelerated aging testing
- More Electric Aircraft testing
- Flight testing
- Emissions testing
- Materials testing
- Aerodynamic testing
- Quality control testing
- Telemetry
- EMC testing technologies and services
- NDT systems
- Data acquisition tools
- Landing-gear test rigs
- Automated testing and compliance systems
- Fire and safety testing technologies
- NVH testing
- Engine testing
- Simulation and modelling
- Lightning strike testing and modelling
- Climatic testing
- Propeller design and efficiency
- Electric motor testing
- Battery testing
- Instrument, avionics, and flight-data controls test and development tools
- Cabin component and design validation
- Electrical and communication system testing
- Airframe testing and development systems
- Composites testing

And much more!

Bringing the pages of Aerospace Testing International to life!

EVENT PARTNERS

AIRBUS aerospace valley

SPONSORED BY

AVL EMERSON. ni INSTRON SAFRAN

SUPPORTED BY

Invest in Toulouse

> **“We want to keep the handling as it is”**
>
> **RICHARD ALEXANDER, AIRCRAFT INTEGRATOR, CAE**

FLASH-2
ENGINeUS™
FLASH-2
ENGINeUS

3 // The team is testing Safran’s Engineus motor to assess how it will perform in flight conditions in the Piper Archer *(Photo: Safran)*

and its safety record is well-established, which makes our job easier. It’s an ideal training aircraft, already certified and robust, we just have to electrify it.

“Almost everyone electrifying this class of aircraft is converting an existing airplane. The Pipistrel Velis is based on the Virus – a piston aircraft just like the Archer. Diamond’s is a conversion, Harbour Air’s Beaver and Aura Aero too. We are all following the same kind of pathway,” says Alexander.

The aim is to make a converted Archer as similar to the original as possible. A key consideration is devising ways to ensure that the pilot knows they are in an electric or piston version of the aircraft.

“We want to keep the handling as it is. The performance will change a bit but will be in the same ballpark as the existing airplane. We considered going hybrid, hydrogen combustion and fuel cells. But the battery solution is best for our mission,” says Alexander.

A BROAD CURRICULUM

The final range of the converted aircraft is not being released yet, because the final weight may change. Regarding certification and entry-into-service dates, Filippatos empahsizes the broad nature of the program. “As an engineer, it’s tempting just to see this as a technical challenge, but to achieve entry into service a lot of work has to be done in the background.

“The program involves carrying out infrastructure changes at our FBOs so we can charge electric aircraft,” she says. “It also covers how to incorporate the aircraft into the curriculum and contract changes with our airline customers.”

It is unlikely that a converted Archer will offer sufficient range to deliver the whole curriculum, but this is no different from existing electric aircraft and is a restriction of battery technology. In addition, the handful of Velis already being used in the USA are not located in the same places as CAE flight schools, meaning there is no crossover for electrical charging infrastructure.

An FAA exemption for crediting pilot training in the Velis has also only just been granted and that is only to a basic level. “The Archer, can take pilots a longer way through their training program,” says Alexander.

CAE has never developed an aircraft before. The electric Archer project’s location on the fringe of its Montreal campus can be seen to reflect the company’s cautious approach to it. But the program also embodies CAE’s entrepreneurial spirit, which in the last 20 years has helped it grow from a simulator maker into a training provider. If the company can successfully expand into electric aviation remains to be seen, but the program has the backing of senior leaders in the business. “This will be a commercially available STC and conversion kit,” says Filippatos. “The architecture we are developing will be exportable to other aircraft.

“There’s a lot that needs to be figured out, even just for the experimental aircraft. Not a single day of this program is without challenges,” says Fillipatos.

“But the industry will learn a lot from operating these aircraft. That knowledge and know-how can be scaled up for use in larger aircraft.” \\

4 // CAE increased production rates for its simulators by introducing a modular design

Clean Sky 2
JOINT UNDERTAKING
This project is funded by the European Union

Advance to New Heights

Redefining Aerodynamic Flight Testing with EvoScann®

< < < Channels > > > >
EvoScann®
P-Series
Digital Pressure Scanner
Serial No: 2650
www.evoscann.com

The EvoScann® P10-D is a 10-channel true-differential pressure scanner with a separate barometric sensor.
Designed for flight testing, it delivers accurate and detailed insights into overall aerodynamic and static pressure distribution, crucial for optimizing aerodynamic design.

Learn more at www.EvoScann.com

EvoScann®

// BEN SAMPSON

Time to rethink hydroge

// This Airbus ZEROe fuel cell mock-up was displayed at the ILA Berlin Air last June *(Photo: Airbus)*

n flight?

Airbus' adjustment of its ambitious hydrogen-electric development program is a testament to the scale of the task facing the aviation industry to decarbonize

The news that Airbus is to scale back its ZEROe hydrogen aircraft development program was received with a mix of dismay and lack of surprise by most in the sector. The ZEROe program was launched in 2020 and aimed to put a hydrogen-propulsion aircraft into service by 2035. Instead, there won't be an Airbus hydrogen-electric aircraft flying until 2045, and the number of engineers working on hydrogen R&D globally is being slashed.

Speaking at the company's 2024 financial results event last month, Airbus CEO Guillaume Faury blamed the cutbacks and delay on the shared lack of progress in developing a hydrogen ecosystem – fuel production plants and transmission infrastructure. Essentially, Airbus now believes hydrogen fuel won't be available at airports in 2035, making a hydrogen-fuelled aircraft commercially unviable.

Faury defended the R&D done so far, stressing that a hydrogen-fuel cell powertrain is technically feasible and the best way to achieve a zero-emissions aircraft. Indeed, work on the "critical technologies", such as fuel cells and cryogenic systems will continue.

But Faury also admitted that an eventual hydrogen fuel cell-powered aircraft could look very different from the ZEROe concepts publicized over the last five years. "The aircraft must make sense in terms of size, range and passenger capacity for between 2035 and 2045. We must look at the complete equation," he said.

SMALL WINS

The industry knows that hydrogen fuel cells can power aircraft, arguably most credibly thanks to flight testing achieved by German startup H2fly of its four-seat HY4 demonstrator in September 2023. The aircraft flew at altitudes of up to 7,200ft and its longest flight lasted three hours. A modified Pipistrel light aircraft, HY4 is powered by cryogenic liquid hydrogen, which can give range and performance equal to fossil fuels minus the carbon emissions.

H2fly was acquired by US eVTOL aircraft developer Joby in 2021. Parts of H2fly's propulsion system are being tested in Joby's eVTOL. H2fly also continues to develop its H2F-175 fuel cell propulsion system, which can output 175kW of power.

Josef Kallo, now chief technology officer at H2fly agrees the largest barrier to using hydrogen in aviation is its production and distribution. "The main challenge for hydrogen aviation is to build the infrastructure to ensure a reliable and cost-competitive supply of hydrogen.

"Developing a comprehensive hydrogen ecosystem will require significant investment, particularly in renewable energy for green hydrogen production and specialized airport refueling infrastructure. This includes the development of storage and distribution networks to support hydrogen-powered aircraft.

"While it's difficult to predict the exact impact of Airbus' decision to scale back its hydrogen R&D efforts, we continue to believe in hydrogen as an aviation fuel and are fully committed to contributing to the development of a hydrogen ecosystem, starting with smaller electric aircraft."

REALISTIC READJUSTMENT

The most important part of any hydrogen-electric aircraft is the fuel cell. UK-based Intelligent Energy already supplies hydrogen fuel cell systems to the automotive, telecoms and construction sectors. Founded in 2001 and with a workforce today of around 200 people, the company also worked with Boeing to build and fly the world's first fuel cell-powered aircraft in 2008. Jonathon Douglas-Smith, head of aerospace sales at Intelligent Energy believes most people in the industry were expecting Airbus to scale back its hydrogen ambitions: "Airbus were trailblazers with ZEROe. But it is too large of an undertaking for them to do it all themselves," he says.

"We don't think it damages the route to market for hydrogen aircraft, it is a realignment that will allow suppliers to help Airbus make it happen."

Intelligent Energy has developed an aviation fuel cell as part of the UK Government-funded £54 million (US$68 million) H2GEAR project. The 300kW capable fuel cell system was launched to the market in July 2024 at the Farnborough Airshow. The IE-FLIGHT 300 (F300) is for Part 23 aircraft with up to 19 seats and eVTOLs. The first OEM customers are expected to be announced soon, with first deliveries planned for 2027.

During the next two and half years, engineers at Intelligent Energy will develop the balance of plant for the F300. This includes the ancillary parts of the system such as the heat exchanger, air compressor and hydrogen recirculation module.

Douglas-Smith says, "The market wants a more complete balance of plant with the fuel cell system because it removes the customer's need to understand the complexities of how to run fuel cells optimally. We have 24 years of experience building fuel cell systems, so it makes sense for us to do it."

Intelligent Energy is also developing the larger F500 fuel cell system based on the same underlying lightweight fuel cell stack technology for aircraft larger than 19 seats. "Scaling up is part of our roadmap," says Douglas-Smith. "Larger aircraft need a higher specific power and more time is

1

1 // The IE-Flight F300 has been in development since 2019, initially under the UK Government funded H2GEAR program *(Photo: Intelligent Energy)*

2

2 // The F300 has been optimized to dissipate heat as efficently as possible when integrated into an aircraft's propulsion system *(Image: Intelligent Energy)*

> **"The market wants a more complete balance of plant with the fuel cell system because it removes the customer's need to understand the complexities"**
>
> JONATHON DOUGLAS-SMITH, HEAD OF AEROSPACE SALES, INTELLIGENT ENERGY

> **“The aircraft must make sense in terms of size, range and passenger capacity for between 2035 and 2045. We must look at the complete equation”**
>
> **GUILLAUME FAURY, CEO, AIRBUS**

needed to develop the technology for those power densities. We have R&D programs that are looking at the technology.

“But we see larger aircraft as a longer-term market,” he says. “The market for smaller aircraft will be a lot sooner, towards the end of this decade, rather than the 2040-45 timeframe for fuel cell powered aircraft greater than 100 seats.”

FUEL CELL COMPETITION

Intelligent Energy has invested heavily and made good progress with its aviation fuel cell, underlining its belief in the market. Other companies, such as Sweden’s Powercell are also betting on fuel cells for aviation applications. Having supplied the fuel cells for its prototypes, Powercell is supplying the stacks for ZeroAvia’s first 600kW powertrain (ZA600), which is also intended for use in Part 23 aircraft.

The two companies are also partnering on the R&D for the more powerful ZA2000 powertrain, which is aimed at turboprop aircraft of up to 80 seats and will be based on Powercell’s heavy-duty fuel cell stack design. Powercell is also supplying its 300kW HDS300 (heavy duty system) fuel cell stack and engineering support for an 18-month aviation project in Japan.

Meanwhile, German automotive supplier ElringKlinger’s aviation fuel cell technology has been licensed by Airbus and is being developed as part of a joint venture company called Aerostack. Its proton exchange membrane (PEM) fuel cell is based on ElringKlinger’s NM12 stack, which provides a maximum output of 205kW. The fuel cells were used in a successful ground test of a 1.2MW powertrain last January in Ottobrunn, Germany.

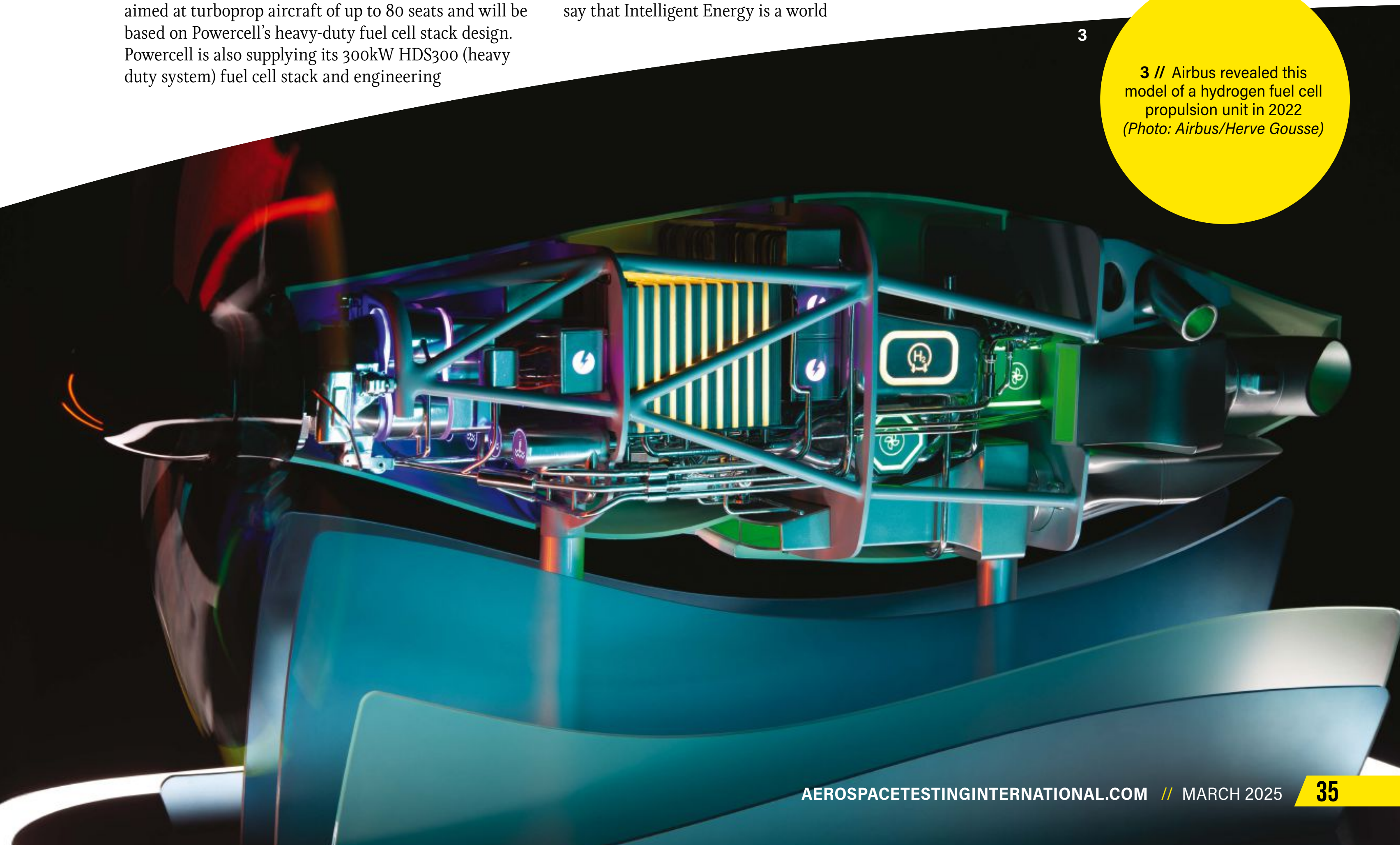
“Airbus has acknowledged that essential hydrogen fuel cell component technology is going to take longer than they anticipated to reach the performance levels needed for the 100-seater aircraft,” says Douglas-Smith. “I would confidently say that Intelligent Energy is a world leader in this field. But there is a long way to go – the regulations and conformity to airworthiness standards are still being written by EASA and the FAA – although roadmaps were published by both regulators last year.”

HEAT DISSIPATION

The H2GEAR project developed Intelligent Energy’s stack technology to TRL 5. One of the biggest challenges the company has encountered with developing fuel cells for use in aviation is the high-altitude environment.

“We tested the stack module in representative conditions of operating altitudes in barometric chambers. The stack was designed to specifically withstand the pressure differentials that can be expected at altitude. The seals were a key part of the design,” says Douglas-Smith.

“The air is less dense at altitude, making cooling harder. We see this already with our products for our drone customers, who use lower



3

3 // Airbus revealed this model of a hydrogen fuel cell propulsion unit in 2022 *(Photo: Airbus/Herve Gousse)*

> **"The introduction of hydrogen is so radical it will likely be done incrementally and at first sub-optimally – a big issue is storage volume"**

DR CRAIG LAWSON, READER IN AIRFRAME SYSTEMS, CRANFIELD UNIVERSITY

powered cells featuring air-cooling. Our patented evaporative cooling system is more thermally effective and the best way to get the heat out of the stack."

Fuel cells are 50% efficient over life. A fuel cell delivering 100kW of power produces 100kW of heat which needs to be dissipated. The Flight F300's evaporative cooling system injects deionized water into the very hot stack, which evaporates. Heat is transferred through vaporization, which is a more effective way of removing heat from the cells than liquid cooling.

Crucially for aviation applications, the increased effectiveness of evaporative cooling enables the thermal management system to be smaller and lighter. Injecting water directly also humidifies it, which optimizes the performance and lifetime of the stack.

Now-defunct hydrogen aviation startup Universal Hydrogen used USA company PlugPower's automotive fuel cell for its testing program, integrating a system into the nacelle of a Dash 8 aircraft. Experts were quick to see the cooling challenges that had been encountered by the Universal Hydrogen team. "They needed really large air scoops and radiators, adding weight and drag. It became obvious it wasn't a viable solution to go to market with," says Douglas-Smith.

"That was one of the motivations for us to develop the F300, which beyond the evaporatively cooled technology, has a high temperature that can further shrink the thermal management and nacelle packaging. That's one of the core development activities now."

OTHER ON-AIRCRAFT CHALLENGES

Thermal issues are not the only concern when integrating a hydrogen-electric fuel cell powertrain into an aircraft. Dr Craig Lawson is a reader in airframe systems at Cranfield University. Last month ground was broken on the University's £69 million (US$87 million) Hydrogen Integration Incubator (CH2i) project, which will be one of the largest hydrogen R&D facilities in Europe.

Lawson says, "The introduction of hydrogen is so radical it will likely be done incrementally and at first sub-optimally. One of the big issues is storage volume.

"With a tube and wing design, you can't put hydrogen fuel in the wings because they are too thin. We need cylindrical, ideally spherical tanks. You can put them in the fuselage, but then you are compromising on passenger space and payload," says Lawson.

According to Lawson studies looking at modifying existing aircraft with hydrogen fuel systems have concluded the result will be aircraft with inferior payload and range capabilities compared to current models. "We are going to have to accept a hit on payload and range to have a zero-carbon aircraft," he says.

In addition, a change in energy carrier means massive changes to certification and regulations. The safety case for hydrogen as an aviation fuel is yet to be fully explored.

"We understand the failure modes of kerosene, so it's OK to have it relatively near an aircraft's occupants. But it's not clear that the failure mode of a hydrogen tank is going to be anything other than catastrophic," says Lawson.

"That means to some people, if

GKN AEROSPACE

4

ZERO EMISSION HYDROGEN AIRCRAFT
H2GEAR

4 // The H2FlyGHT project aims to fly a 2MW hydrogen electric powertrain by 2030

5 // GKN and easyJet have been partnering on hydrogen propulsion since 2022 *(Images: GKN Aerospace)*

6

6 // GKN has studied 19, 48 and 96 seat regional airliners with hydrogen-electric propulsion for H2GEAR *(Image: GKN)*

5

the hydrogen is within the same fuselage as the occupants, the aircraft is uncertifiable because any failure is going to be catastrophic."

Hydrogen could be stored on tanks mounted on wings, but again this is a sub-optimal solution. Alternatively in a blended wing body (BWB) aircraft, which features a lot of storage volume, the hydrogen tanks could be placed outboard of the passengers.

"BWB is probably the best solution for a hydrogen airliner," says Lawson.

BWB is an immature design, although studies have shown it to be efficient for large-capacity aircraft, no matter what the energy carrier. However, interest is growing in BWB, thanks to the push towards hydrogen as a fuel. California, USA-based startup JetZero plans to start flight testing a full-scale BWB aircraft in 2027. "There's research coming in Europe and our Exaelia project has just started, looking at long range, A350 replacements – green airliners," says Lawson.

POWER DISTRIBUTION SYSTEMS

GKN Aerospace heads up the H2GEAR program, which started in 2020 and concludes in September. H2GEAR aims to develop a liquid hydrogen propulsion system for sub-regional aircraft that can be scaled up to larger aircraft. It is the largest single program ever awarded by UK funding body the Aerospace Technology Institute (ATI). As well as fuel cell company Intelligent Energy, partners include turbocompressor company Aeristech and several research universities.

H2GEAR is now reaching its demonstration and testing phase. ATI has awarded GKN other hydrogen research programs, including the £40 million, four-year HyFIVE program, which focuses on liquid hydrogen storage and fuel conditioning systems, and the £44 million H2FlyGHT, a follow-on to H2GEAR.

H2FlyGHT aims to demonstrate a 2MW hydrogen-electric propulsion system in flight by the end of the decade. Partners include: Parker Meggitt, which will be collaborating on thermal management and balance of plant for the fuel cell system; the University of Manchester, which will focus on the motor coil design and the University of Nottingham, where researchers will support the full motor design and scale-up and cryogenic inverter technology development.

Mike Hales is chief engineer of hydrogen propulsion at GKN Aerospace and has been leading the H2GEAR project. He says, "At its heart we are building an energy conversion system – liquid hydrogen is converted into DC power via a fuel cell, then distributed around the aircraft and provides the propulsion power.

"It's converted to AC power in an inverter located next to the electrical machine, which converts that into torque to run the propulsor. The powertrain would be similar if you were using GH2 as a fuel source, but the H2GEAR architecture with an LH2 fuel source to provide some preferential technical features."

Hales believes the 50% fuel cell efficiency achievable today can be improved upon through advances in chemistry development and materials technology. Hyperconducting materials are being used in the DC power distribution system and the electrical machine's stator. These behave similarly to superconductors but use metals such as high-purity aluminum, giving low

> **“With projected improvements in fuel cells and other components, we believe it’s feasible to scale up to single-aisle aircraft”**
>
> **MIKE HALES, CHIEF ENGINEER OF HYDROGEN PROPULSION, GKN AEROSPACE**

resistivity at cryogenic temperatures without the abrupt failure risks of superconductors. “Hyperconductors are also an obtainable near-term technology and can be made reliably today in the form we require,” says Hales.

The reduced power losses in the distribution system mean more current can be transferred. Chunky copper cables can be replaced with smaller conductors and a lower voltage to reduce the weight by up to four times. The power distribution system can use a +/- 270V standard, already in use today on aircraft.

“Cryogenic cooling allows us to improve the efficiency of power distribution and propulsion. With hyperconducting materials, we see around a 10% improvement in electrical transfer efficiency, which directly translates into a smaller and lighter system for a given power,” says Hales.

“By cooling the electrical machine’s stator windings to cryogenic temperatures, we dramatically reduce AC and DC losses. This enhances efficiency and helps us keep the system compact.”

H2GEAR TESTING

Researchers on H2GEAR are integrating systems and have been testing fuel cells since the end of 2023. “A big milestone last year was the assembly of our the demonstrator motor. It’s the first machine of its type that contains hyperconducting high-purity aluminum. That motor has been on test at the University of Manchester. We’re currently increasing its shaft power to verify its efficiency.”

GKN researchers have designed several concepts, including a notional study aircraft that will be used as a reference from which to study the powertrain in simulation.

“Our research indicates that hydrogen-electric propulsion offers a pathway to zero-emission aircraft. By leveraging cryogenic and hyperconducting technologies, we can improve range capability.

“With projected improvements in fuel cells and other components, we believe it’s feasible to scale up to single-aisle sized aircraft. That could make a meaningful impact on the aviation industry’s emissions footprint.”

Despite also being part of the H2GEAR program, GKN will not be using Intelligent Energy’s F300, because the fuel cell’s development roadmap targets aircraft of more than 100 seats, like Airbus’ plan.

“Fuel cell technology has only really been in development for aerospace for the last five years,” says Douglas-Smith. “There is uncertainty about its limits. It might be capped at 100 or 120-seat aircraft. Right now all we know for sure is it works for smaller aircraft and eVTOLs.”

Similarly to battery-electric aircraft, the path to market for hydrogen-electric will build up from smaller, general aviation aircraft to regional aircraft. and if the technology allows, perhaps on to larger airliners. Even then, the viability of hydrogen-electric depends on a massive cross-sector effort to establish sustainable ways of producing and distributing hydrogen fuel and swathes of new safety regulations. As Airbus has worked out, there is no shortcut to hydrogen aviation. \\

8

9

8 // H2fly’s fuel cell system is being integrated into Joby’s eVTOL aircraft *(Photo: Joby)*

9 // The Hy4 is one of the few aircraft to have flown using LH$_2$ fuel *(Photo: H2fly)*

7

7 // JetZero is building a prototype of a blended-wing body aircraft for the US Air Force *(Image: JetZero)*

DEWESoft®

AEROSPACE TESTING SOLUTIONS

Flight test engineers trust our compact and rugged DAQ systems for physical measurements of all kinds. Ground station engineers take advantage of our full support for PCM and iNET telemetry data, and aerospace data buses like ARINC 429 and MIL-STD-1553. We offer stand-alone as well as distributable, networked DAQ systems into thousands of channels.

ALTITUDE (FT)
198412
15962
FLOW RATE (GAL/MIN)
34012
TURBINE SPEED (RPM)
VELOCITY(MPH)
3221

CHECK OUT THE FULL CASE STUDY

// BEN SAMPSON

Getting ahead in ELECTRIF

ICATION

JEFF ENGLER & COLIN TSCHIDA, CEO & CTO OF WRIGHT ELECTRIC, ON THEIR COMPANY'S PLAN TO DECARBONIZE AVIATION

1

2

After eight years of testing and development, USA-based Wright Electric's goal is as clear and succinct to CEO Jeff Engler as the day he founded the company – to reduce the climate impact of the aerospace industry.

He and his company of around 20 engineers plan to do this by developing the world's most powerful electric motor yet for aircraft, the 2.5MW WM2500, plus the associated inverter, power electronics, and battery.

For the last year work at Wright has been focused on how that electric powertrain could be fitted to a C-130 Hercules, including research with NASA and a detailed proposal published last October. In January engineers did an initial fit check of the WM2500 electric propulsion unit (EPU) at a US Air Force Base.

Wright wants to use a US Air Force C-130 for a flight test program, switching an engine for a hybrid-electric EPU, to prove the benefits of electrification.

According to research, a hybrid-electric converted C-130 could serve a range of 560 miles (900km) to 1,200 miles (1,900km) while giving fuel savings of between up to 44% compared to a conventional fossil fuel one.

Beyond the C-130, Wright's roadmap calls for the EPU to be used to convert BAe 146 aircraft into a regional battery-electric aircraft to be called The Wright Spirit. Eventually, it aims to use the EPU to power an 186-seat clean-sheet airliner called the Wright 1, which will have an 800 mile (1,300km) range and enter service in 2032.

TEST PROGRESS

Wright Electric is making good progress with its EPU. Last month it successfully ran its second generation 2.5MW motor and inverter linked together for the first time.

Strangely though, news about testing progress runs alongside announcements about tactical generators, lightweight batteries, and crop dusters in the company's feed. It may appear that Wright Electric working in multiple industries, but there is a strategy behind it.

"Our business model combines the long-term vision of electrifying the aerospace industry with the short-term aim of finding ways to take our technologies to market before then," says Engler. "We make motors, we make generators, and we are starting to develop batteries so we can fund our vision of large, electrified aircraft."

Wright has been developing tactical generators for the US military since June 2023. The first flight of a 800 kW electric propulsion unit was in November 2023 in a hybrid-electric crop duster made by Spain's Axter Aerospace. Last year it was awarded contracts to develop lightweight batteries by the US Air Force, ARPA-E, and the FAA.

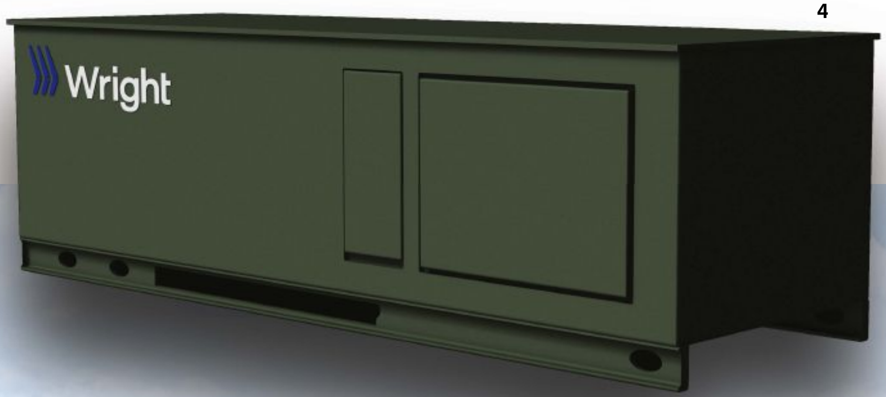
Leveraging core competencies and technologies in adjacent areas makes business sense – but is there a risk the strategy distracts from the company's main goal?

"We are an aerospace component developer first," says Engler. "As we are developing our motors and batteries, we are always looking at the requirements from an aviation technical and standards perspective.

"But we are not going to be booking revenue from our aerospace-grade electric motor until it is certified, and that might be many years. With a long timeline, you will get shocks and surprises along the way. The only way around that is to focus on industry-leading technology and diversify in terms of programs and markets.

"For example with the tactical generators, we can leverage the overlap in technology – motors and inverters – and manufacturing readiness while also

4



3

1 // Jeff Engler, founder and CEO of Wright Electric

2 // Colin Tschida, chief technology officer, Wright Electric

3 // Spain's Axter Aerospace flew a hybrid electric prototype crop duster developed with Wright in November 2023

4 // The 30kW Wright Dynamo Generator is providing revenue and knowledge to the aircraft development program

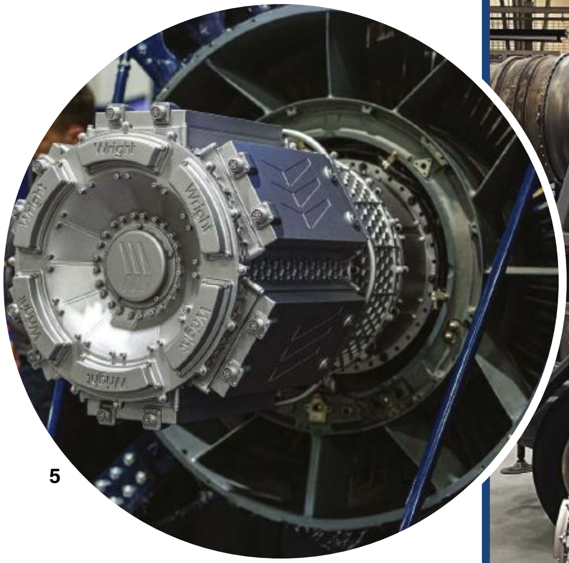
UNMATCHED PRECISION WITH PATENTED HIGH-TEMPERATURE ACCELEROMETERS

Experience unparalleled performance with Parker Meggitt's High-Temperature Piezoelectric (HTPE) Accelerometer Model 6245 and Remote Charge Converter (RCC) Model 1772-3, designed for wide frequency range and extreme temperature measurements up to 1500°F (815°C). Ideal for high-stress environments like aircraft and ground-based gas turbines, this patented technology ensures reliability and precision in the harshest conditions.

PUT
MEGGiTT
1772-1 S/N 10001
CE
ACCEL
ENG1
MODEL
6245

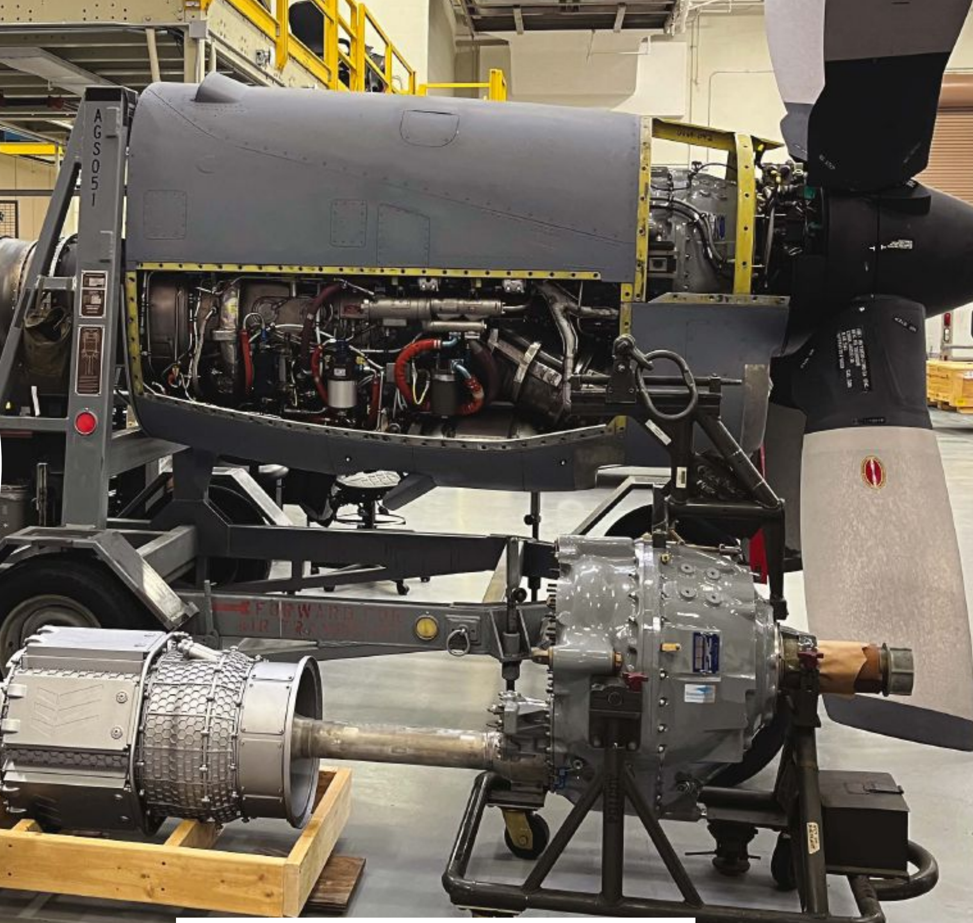
Parker MEGGiTT

Email: DSD-info@parker.com

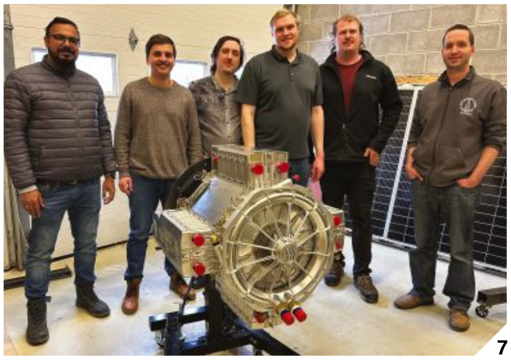


5

"You have to be cleverer with your testing"



6



7

5 // The EPU on the Wright Electric test stand

6 // The WM2500 motor at the front, connected to a C-130 gearbox, with the engine nacelle in the background

7 // Members of the Wright team with the WM2500 Motor and four WV250 Inverters

addressing the needs of our longer term aerospace mission."

Despite this outlook, it is impossible to prepare for every eventuality, and with the US Government funding freeze much of the country's industrial R&D base is at risk. "People tend to forget that when funding agencies such as NASA or the US Department of Energy are putting out funding dollars, it's to train and equip the next generation of engineers. The suppliers and manufacturers who build leading technology that is going to help keep the USA and other parts of the world competitive for many years," says Engler.

TESTING MILESTONES

Engler talks about business strategy and climate change with a fluency that reveals he is a problem solver on the macro scale. In contrast, Colin Tschida, Wright Electric's chief technology officer seems more focused on micro-scale problems.

To Tschida, Wright's most significant testing campaign so far was during the summer of 2024, when the team ran the first-generation motor to around 1.3MW in the lab. "That was a nice test, the motor was running very cool. We were essentially just limited by our test infrastructure," he says.

"Not long after that, we validated our installation system in the lab. The testing showed it was PD [partial discharge] free at 43,000ft, exceeding our design target."

Similarly, after the recent integrated run of the second-generation 2.5MW motor and inverter, the next test campaign will see the same system tested at simulated altitudes in the laboratory. "That's the next big milestone for us," says Tschida.

GROUND-TO-AIR

Partial discharge is an undesirable effect that can happen in high-voltage electrical systems which causes insulation to deteriorate and can lead to electrical fires and explosions. Higher voltages can help reduce the size of an electrical system and have other benefits, but require more insulation to prevent PD, adding bulk and weight, both of which are to be avoided in an aircraft's design.

This voltage/insulation conundrum is typical of the challenge faced by engineers adapting ground-based electrical machines for use in aircraft, explains Tschida. An aviation environment's different requirements can heavily influence both design and testing.

"Another interesting challenge the whole sector is grappling with is reliability," says Tschida. "Industrial electrical systems do not have the same reliability requirements as aerospace ones. The standards are higher in aerospace – failure rates have to be lower. This means you have to be more careful with your component selection and cleverer with your design and testing."

However, the answer to such challenges isn't always to innovate. Sometimes, innovation can introduce more

PolyWorks
Inspector™

Standardize your quality control process with **one universal software**

- Increase measurement specialist expertise across all devices
- Ensure consistency in your 3D measurement process
- Standardize reporting across all hardware

Unify your team and streamline operations with ONE universal software

innovmetric

Contact us: 1-888-688-2061 info@innovmetric.com **www.innovmetric.com**

“The challenge for testing is the high power levels”

8 // Artist’s impression of a future electrically powered airliner produced to promote Wright’s partnership with easyJet

9 // Wright and Columbia University are developing batteries up to four times lighter than lithium-ion, using next-generation materials and AI

time, expense, and risk into a program. “We are careful about where we innovate. We don’t want to do it at every stage,” says Tschida.

“The development of an electric powertrain is completely different from a combustion engine, but there is a lot of heritage in electric motors that we can use – just not all of it.”

So far example the insulation system Wright Electric is using for its motor and inverter doesn’t differ too radically from those used in industrial systems and still uses typical resins and oil.

ELECTRIC TESTING INFRASTRUCTURE

Wright Electric has two test cells, one of which is currently being built. There is a 2MW electric motor dyno, and the team is working on a test rig for an electric ducted fan to test the first and second-generation motors under fan load.

Tschida does not see the physical size of the motor as creating issues during testing: “Our 2MW motor will be similar in size to a PW100 series power turbine. That’s not enormous or too heavy.

“The main challenge for testing is that the power levels are high, which needs more infrastructure and safety devices. The setup becomes more sophisticated and expensive.

“We are also working to reduce the mass for a given power level. We want very high specific power, which creates its own set of challenges.”

A REAL ADVANTAGE

Wright Electric has the ambitious goal of electrifying large aircraft because around 90% of aviation’s carbon footprint and 98% of its noise emissions are from aircraft in that category. However, Engler is keen to emphasize that his company is taking the same pathway to electrification that the market seems to be following – light sports aircraft to regional transport and then larger commercial passenger airliners.

Engler says, “In the long run our megawatt-class machines will be used in clean-sheet aircraft designs, but in the medium term, they will be used in regional hybridization applications.

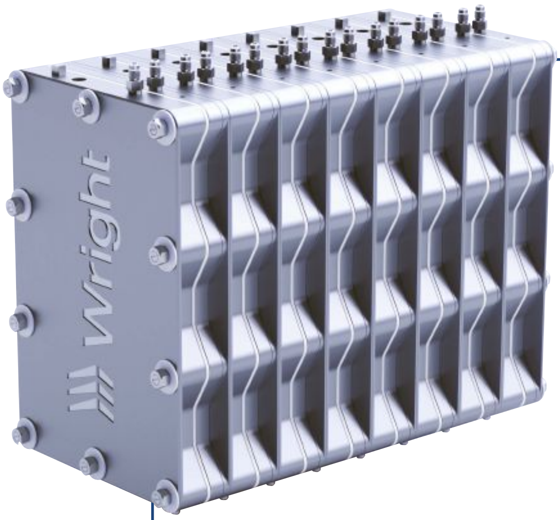
“We don’t always have control over the timelines our products will get to market in because of regulatory and technical challenges, but in terms of the market the industry is coalescing around, we fit into that program.”

This timescale hasn’t stopped partnerships being made with charter jet firm Jetex and airline Easyjet in 2018 and 2020 respectively. These serve a higher purpose than greenwashing says Engler: “Understanding the needs of our customers is crucial to what we are doing.

“There are so many small decisions you have to make when developing new technology that an outside company could never really know all the details. But we are learning from airlines what their specific requirements are – in terms of power, takeoff, runway length. That helps us design the aircraft and the motor.

“There’s a real, tangible benefit to engaging with them early on, beyond the marketing advantage.”

Wright Electric’s goal of electrifying aviation may be straightforward to propose, but the route to achieving guilt-free flying is complex and challenging. Engler and Tschida though are keeping the end-goal firmly set in their sight. Engler says, “When we finished designing the motor, then when we assembled it, and then when we started basic testing, we were proud. You have to regularly take a moment to celebrate what you’ve achieved, even as you keep building and refining.” \\



SUBSCRIBE TODAY: REGISTER ONLINE TO RECEIVE THE NEXT ISSUE FREE!

MARCH 2025
Inside this issue
Aerospace TESTING INTERNATIONAL
// HYDROGEN ON HOLD
What now for hydrogen electric propulsion after Airbus delays its 2035 entry-into-service target?
// SKY HIGH
Unmanned aircraft operations in the stratosphere are about to take-off after years of ground testing
// NDT & AUTOMATION
How robotics and AI combine to increase accuracy and improve the efficency of inspections
Dream delivery
Lead engineers on the Dream Chaser program reveal how the spaceplane has been stress tested ahead of its first launch
WWW.AEROSPACETESTINGINTERNATIO

To receive future copies of *Aerospace Testing International* free of charge, or to register a friend or colleague, please sign up **online now!**

Register free online at:

www.aerospacetestinginternational.com

// JACK ROPER

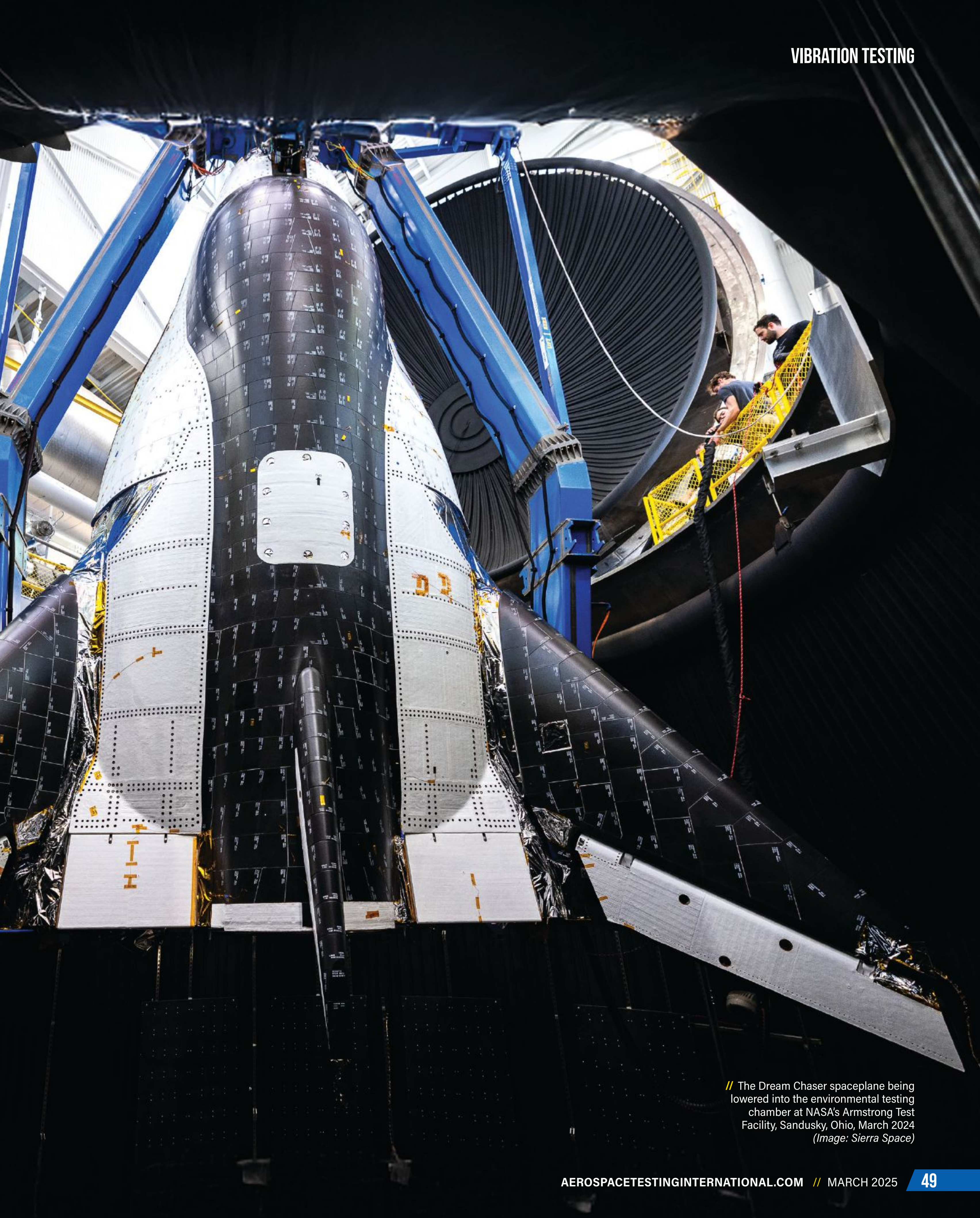
Realistic response

Confidence in the success of the Dream Chaser spaceplane's maiden launch will be high thanks to a testing program that has used the latest technology and methods

Later this year, the Sierra Space Dream Chaser spaceplane is expected to launch into orbit for the first time atop a United Launch Alliance Vulcan Centaur rocket, loaded with cargo bound for the International Space Station. Once in space, it will separate from its fairing and catch up with the ISS as both vehicles hurtle around Earth at 17,000mph (273,000km/h).

"The International Space Station [ISS] pulls us in with its arm," explains Sierra Space senior vice president of safety and mission assurance, Angie Wise. "We remain docked for up to 75 days while the crew unloads our Shooting Star cargo module and reloads it with trash. We then push away, re-enter Earth's atmosphere and autonomously land on a runway, while Shooting Star separates and burns up on re-entry."

In generating the immense kinetic energy required to escape Earth's gravity, the Vulcan Centaur will expose Dream Chaser and Shooting Star to punishing levels of vibration and sound. Comprehensive vibroacoustic testing at facilities including at the NASA Armstrong Test Facility (ATF) in Sandusky, Ohio aims to ensure their survival.



// The Dream Chaser spaceplane being lowered into the environmental testing chamber at NASA's Armstrong Test Facility, Sandusky, Ohio, March 2024 *(Image: Sierra Space)*

"We have predictions of the environment the payload will see on the launch vehicle," says Luke Staab, who was ATF test manager for the Dream Chaser tests. "Because Dream Chaser will dock with the ISS – which has humans aboard – our safety standards increase. We want to find any problems on Earth, so we don't have to fix them in space."

EARLY TO MODAL TESTS

Structural and vibration tests expose a vehicle to forces expected during launch and measure its responses. These responses are already well-understood in computer models, which physical tests serve to validate. Early-build modal tests induce vibrations into structures and use accelerometers to capture natural resonances and mode shapes, which are crucial in tuning virtual models to physical spacecraft.

Dream Chaser underwent static load tests at the Sierra Space Dream Factory in Louisville, Colorado. "We did those before integrating major subsystems in case we had to modify the primary structure," says Sierra Space's vice president of integration and test, Klint Combs. "We mounted the vehicle on a load frame, attached more than 700 strain gauges, applied loads across the structure, and verified the results against our model."

Pyrotechnic release mechanisms will enable Dream Chaser to separate from its launch vehicle and the Shooting Star before re-entry. Shock event tests conducted jointly with rocket provider United Launch Alliance (ULA) demonstrated these mechanisms and the vehicles' abilities to withstand the shocks they induce.

"We also tested release mechanisms for the solar arrays, which are folded inside the fairing and then released in orbit," says Combs. "We fired those release mechanisms, in particular to verify that none of the avionics are affected."

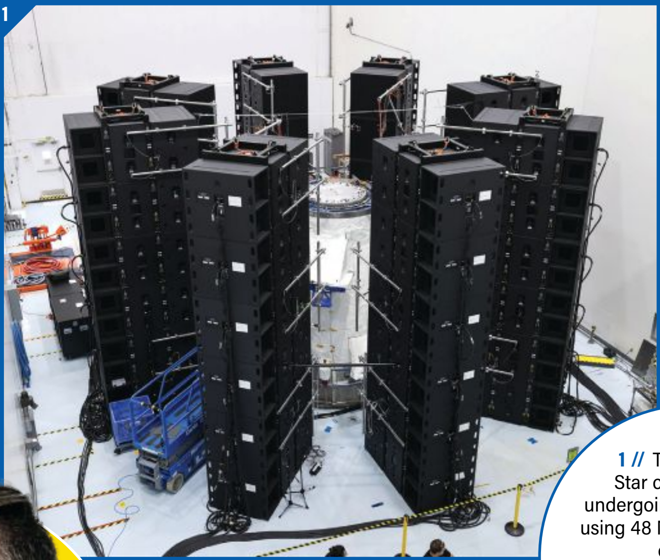
MECHANICAL TESTING

Dream Chaser's next stop was the Vibroacoustic High Bay at ATF, home to the world's largest vibration table. Originally built to accommodate testing of the Orion spacecraft, the donut-shaped table required a special cover to accommodate Dream Chaser and Shooting Star upright in launch configuration for mechanical vibration tests in the 2Hz to 100Hz range.

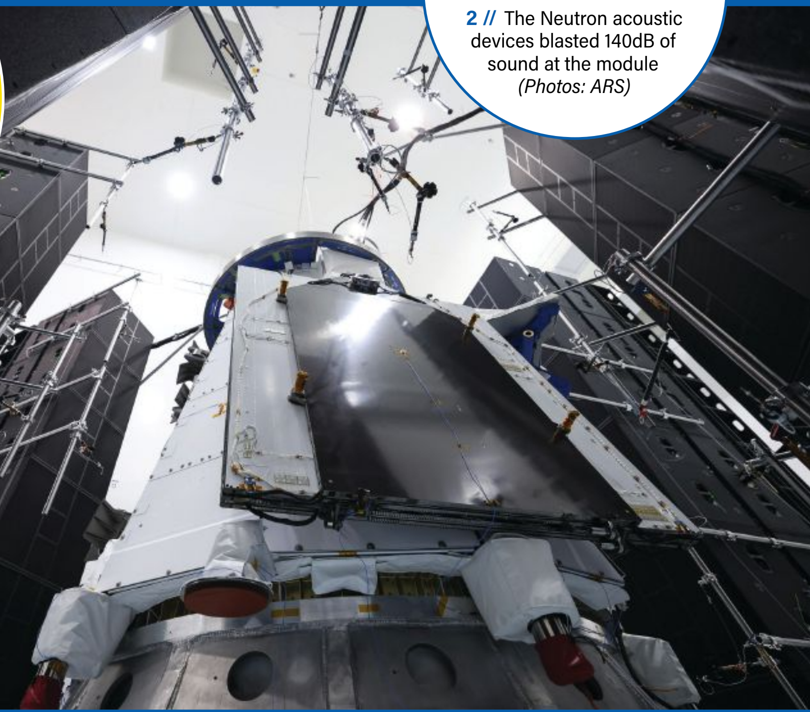
"The system is powered by hydraulic actuators allowing us to test in different directions without changing the test article's configuration," says Staab. "We tested to a qualification level which includes some margin, capturing data from thousands of channels of instrumentation."

Spaced across six weeks, individual tests took less than five minutes, but required months of preparation. NASA honed its control of the table at the required frequencies using a pathfinder

> **"On the vibration table, we test like we fly"**
>
> KLINT COMBS, VICE PRESIDENT OF INTEGRATION AND TEST, SIERRA SPACE



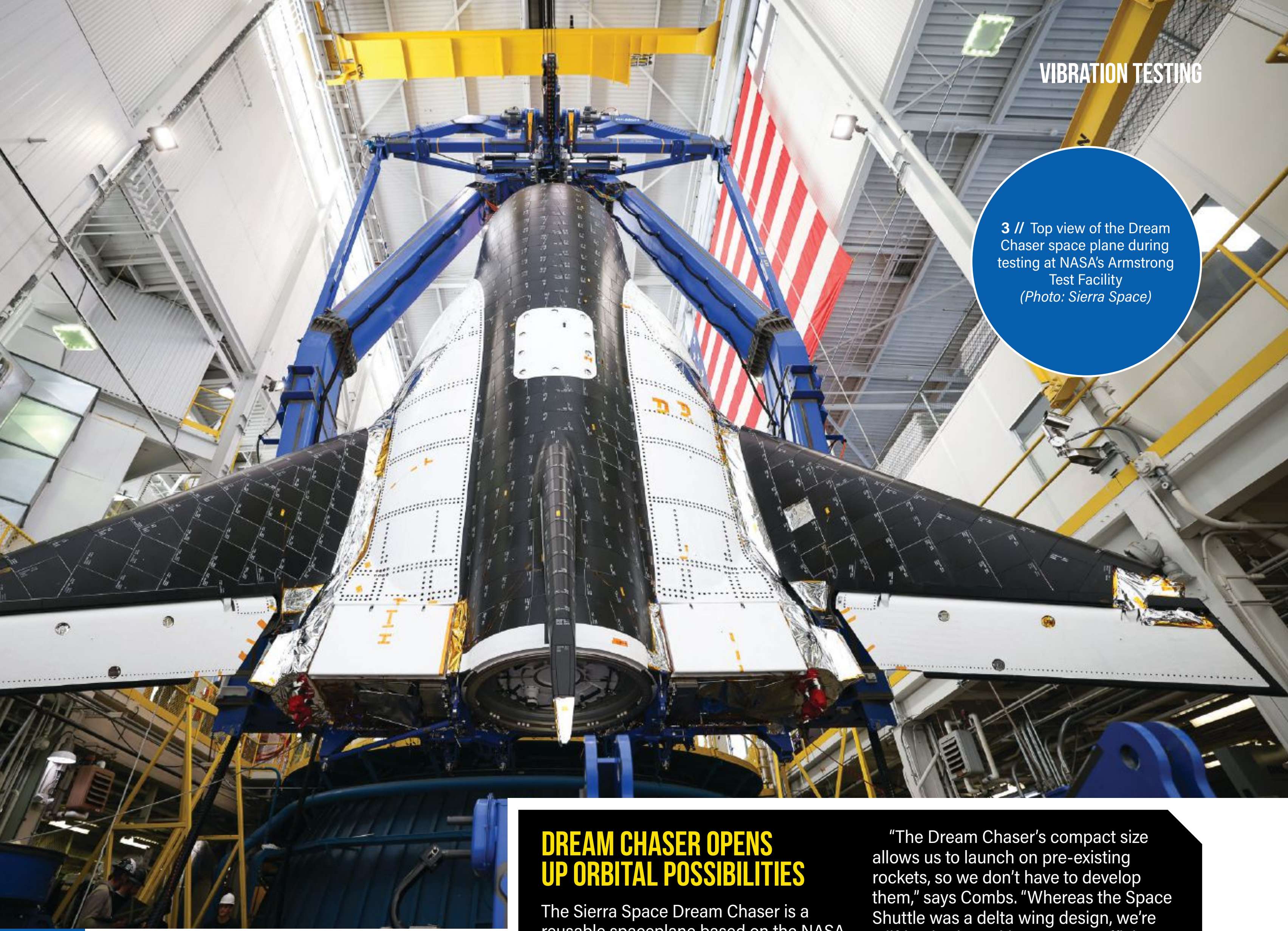
1



2

1 // The Shooting Star cargo module undergoing DFAN testing using 48 Neutron acoustic devices

2 // The Neutron acoustic devices blasted 140dB of sound at the module *(Photos: ARS)*



3 // Top view of the Dream Chaser space plane during testing at NASA's Armstrong Test Facility *(Photo: Sierra Space)*

test article to replicate Dream Chaser's mass. "On the vibration table, we test like we fly," says Combs. "We put the spaceplane and module together in launch mode with all systems powered on. We exposed them to lower frequencies mechanically induced by the rocket, demonstrating it will survive that part of the launch."

Before the vibration tests, NASA implemented a modal fixed-base correction method developed by ATA Engineering. A novel proxy for modal testing, the method isolates a test article's fundamental frequencies by analysis to eliminate the vibration table's movements. It was performed on a space-bound test article for the first time.

Vibration tables recreate mechanically coupled, low-frequency energy transferred from rocket to spacecraft via bolted joints, while acoustic tests involve higher-frequency, decoupled pressure waves traveling through the air. Vibration most affects massy components, whereas sound excites thinner parts like panels and lenses.

"Vibration tests stop at 100Hz, whereas acoustic tests go up to 10kHz," says Acoustic Research Systems (ARS) director of applications, Dale Schick.

"They test workmanship at lower and higher frequencies. If you compare pre- and post-low-level tests

DREAM CHASER OPENS UP ORBITAL POSSIBILITIES

The Sierra Space Dream Chaser is a reusable spaceplane based on the NASA HL-20 lifting body concept. Originally conceived as a crewed vehicle, Sierra pivoted to a cargo variant for NASA's Commercial Resupply Services Contract. Dream Chaser Tenacity will rendezvous with the International Space Station (ISS) later this year, its non-reusable Shooting Star module laden with cargo.

"Since the Space Shuttle retired, there's been a need for a versatile, reusable spacecraft to support missions in low-Earth orbit, including cargo resupply and crewed transport to ISS and future orbital platforms," says Sierra Space's vice president of integration and test, Klint Combs. "Our vehicle can also be an independent orbital science platform."

Like the Space Shuttle, Dream Chaser is reusable, lands on a runway and provides a low-*g* re-entry environment favorable to microgravity experiments. Designed to provide affordable space access and unlock a LEO economy, it is smaller and lighter than the Shuttle.

"The Dream Chaser's compact size allows us to launch on pre-existing rockets, so we don't have to develop them," says Combs. "Whereas the Space Shuttle was a delta wing design, we're a lifting body, making us more efficient on re-entry and better for whole-vehicle heat dissipation."

Plans for a crewed variant require just a few modifications. Tenacity will launch with wings folded inside a fairing, but a crewed variant would launch unfaired to accommodate an emergency abort system.

"We will be able to separate if there's a bad day on the rocket," says Sierra Space senior vice president of safety and mission assurance Angie Wise. "For re-entry, we'll add some dissimilar redundancy and consider how much controllability we give the crew."

Tenacity already complies with many of NASA's rigorous safety standards for human-rated vehicles.

"We have to keep cargo pressurized and be able to fly live animals," says Wise.

"We mate with the ISS and have astronauts going in and out unloading cargo, so life support is already incorporated."

and all the frequencies align, your test article is well-constructed."

ACOUSTIC TESTING

In September 2024, Shooting Star underwent direct field acoustic testing (DFAT or DFAN) in the Space Systems Processing Facility (SSPF) at NASA Kennedy Space Center, Florida. 48 ARS-developed Neutron acoustic devices positioned in stacks of six blasted the module with sound up to a proto-flight qualification level in excess of 140dB. Individual microphones were used to validate and control the field of each acoustic device.

"Our Neutrons are building blocks, like Lego," says Schick. "We load them in, attach microphone support structures, stack them up, connect the stacks to amplifiers and perform a bare chamber run to demonstrate capability to the customer. We then wheel in their device and connect accelerometers to do the validation."

Performed at SSPF for the first time, DFAN has emerged as an alternative to reverberant field tests. These are conducted in acoustic chambers where sound produced by pumping compressed nitrogen through electro-pneumatic horns bounces around, becomes diffuse and recreates the launch environment.

"Reverberant tests are notoriously hard to control," says Schick. "The chambers are expensive and create nitrogen-rich environments where anyone walking in would asphyxiate. Because they're not portable, you have to ship your bird to the chamber, but we come to you and build the test around your spacecraft."

Following the Shooting Star test, ARS will perform DFAN tests on Dream Chaser itself. Whereas the Shooting Star test deployed 48 Neutron speakers in stacks of six, the Dream Chaser test requires 90 Neutrons in stacks of ten to match the vehicle's height with a direct field where sound is the most evenly distributed.

Hundreds of accelerometers will measure the local acceleration response of each panel, part and instrument, each producing a specific signature whose peaks and troughs of frequency and amplitude should match Sierra's mechanical analysis. The key outcome is model validation and prior modeling makes failure comparatively unlikely.

"Failure could take two forms," says Schick. "One is a telemetry or electrical failure, if you excite some oscillator in a component. But more likely is a workmanship failure, because something wasn't torqued correctly or needs more fasteners. That simply means you understand your part better now, so you redesign it and retest."

A SOUND TESTING APPROACH

The patented design of the Acoustic Research Systems Neutron acoustic devices used in direct field acoustic (DFAN) tests enables them to produce rocket launch levels of sound from the power of a single wall outlet.

"Other systems use at least three times more power and risk burning drivers more often," says Acoustic Research Systems (ARS) director of applications, Dale Schick. "We put lots of drivers into one Neutron and configure them to be super-efficient. Each Neutron produces the same broadband energy from 20Hz to 10kHz. We've never blown one driver, even for 151dB tests."

Founded after demand for live sound rental equipment disappeared during Covid, ARS has rapidly grown its peripatetic DFAN business. While Shooting Star is the largest payload tested by DFAN to date, the forthcoming Dream Chaser test will be almost double the size. Large-scale DFAN tests create a certain rock-star cachet.

"Like the launch, it's a test people don't want to miss," says Schick. "The company CEO always turns up. People think it's the coolest thing ever – almost like they want an autograph."

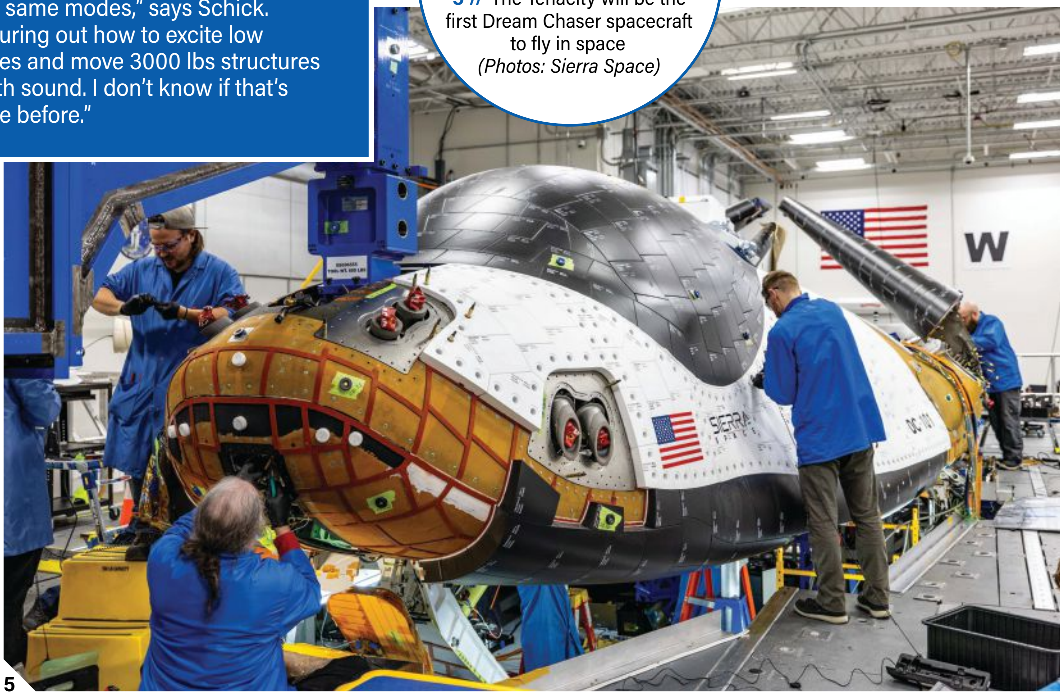
Now, ARS hopes to use sound as the forcing function in the modal tests crucial to creating lifelike computer models. Currently, costly, expert-led modal testing excites structures with hammers or shakers. "We think acoustic energy can excite the same modes," says Schick. "We're figuring out how to excite low frequencies and move 3000 lbs structures to 2Hz with sound. I don't know if that's been done before."

4

TENACITY
DC-101

4 // The Dream Chaser with wings folded. This allows it to fit inside a rocket's fairing during launch

5



5 // The Tenacity will be the first Dream Chaser spacecraft to fly in space *(Photos: Sierra Space)*

HBK
HOTTINGER BRÜEL & KJÆR

VIBRATION TESTING

Solutions for the entire measurement chain

SHAKERS - ACCELEROMETERS - DAQ - DATA ANALYSIS

hbkworld.com

AIM
RIGHT ON TARGET

The Whole is more
than the sum of its Parts

From Modules to Systems -
We have you covered!

MIL-STD-1553
STANAG3910/EFEX
ARINC429
AFDX®/ARINC664P7
Fibre Channel
ARINC825
Ethernet (up to 10 Gbit/s)

Modules - Software - Systems

www.aim-online.com

Angie Wise leads a Sierra Space workmanship team that closely shadows technicians, performing inspections after assembly and where an issue identified in testing has been fixed. When an asset like Dream Chaser completes a test without revealing any workmanship issues, there are plenty of high-fives.

"During testing, we don't want eventful days," says Wise. "Sometimes we find abnormal responses and that's fine. That's why we test on the ground – so we don't have issues on orbit."

> **"If available, previous flight data is used to define test environments"**
>
> **ANGIE WISE, CHIEF SAFETY OFFICER AND SENIOR VICE PRESIDENT OF MISSION AND QUALITY ASSURANCE, SIERRA SPACE**

RE-ENTRY TESTING

The Dream Chaser Tenacity cargo spacecraft will launch inside a fairing, but a crewed variant may sit unsheathed atop a rocket. Launch and ascent is a key mission phase for any spacecraft, but cannot be wholly simulated. Responses to loads, sound waves and vibration are tested separately and wedded in models.

"Coupled load and acoustic analyses predict low-frequency and high-frequency environments, which we assume will combine linearly," explains Staab. "If available, previous flight data is used to define test environments. Acquisition systems and instrumentation continually improve. We inch closer to realism, adding a margin to reflect uncertainty."

On re-entry, Dream Chaser will hit the Earth's atmosphere at Mach 25 and create friction-induced temperatures around 2,500°F (1,370°C), before slowing and landing autonomously on a runway. Its primary structure and landing gear will be tested under loads associated with touchdown, braking and crosswinds, while flight-testing saw a Dream Chaser test article dropped from a helicopter at 10,000ft.

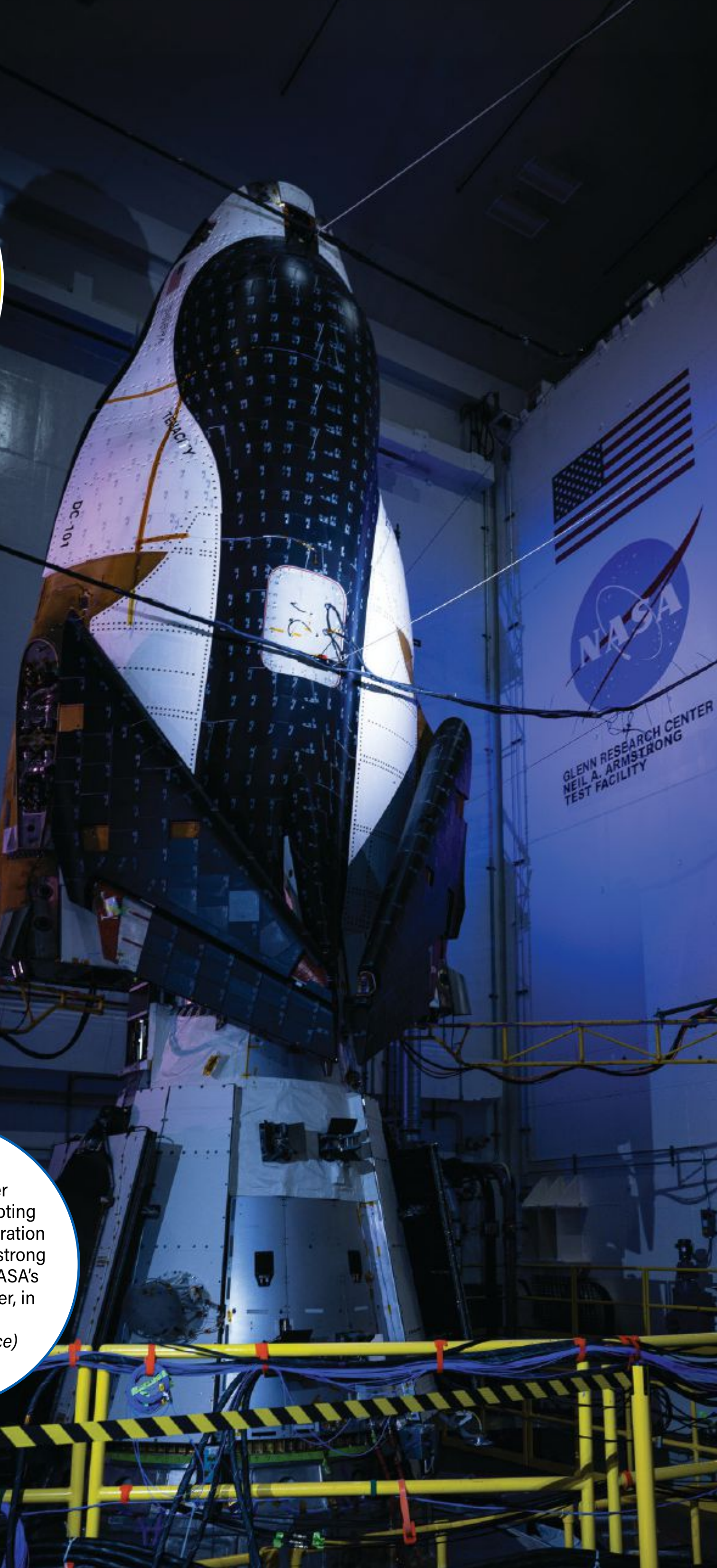
"We demonstrated the vehicle shape working as expected," says Wise. "Second test, we added maneuvers taking it off-course. Our guidance, navigation and control algorithms adjusted and brought it back to the runway."

The energy demands of heating a full-size spacecraft to 2500°F (1,370°C) make recreating the hot phase of re-entry impossible on Earth. Dream Chaser's thermal protection system combines silica-based tiles for the belly and heatshield with TUFROC composite covering the nose and leading edges. Whole-system performance is extrapolated from subsystem component tests.

"Arcjet testing can expose individual tile designs to re-entry temperatures and test how small assemblies of tiles perform together," says Combs.

"We can also demonstrate a history of multiple vehicles using similar technology with a good survival rate."

Combs and Wise have devoted much of their careers to a spacecraft finally poised for its maiden launch. The company ethos encourages employees to enjoy the journey, while ground tests can assuage many uncertainties. Yet anxiety persists. "They pay me to worry about the mission," says Wise. "Our team assesses the possible failures and ensures we do all the testing needed before flight. When the vehicle stops on the runway, that's when you'll see me relax." \\\\



6

6 // Dream Chaser stacked atop the Shooting Star Module during vibration testing at the Neil Armstrong Test Facility, part of NASA's Glenn Research Center, in Cleveland, USA *(Photo: Sierra Space)*

iMPULSE X-Wings35™

Swiss Quality since 1973

ACUTRONIC
Simulation & Test

1 **Flexible Solutions & Options**
20 to 200 kN, Air- / Water-Cooled
Headexpander & Sliptables in all sizes

2 **User centered design**
Automatic centering & tilt
Preventive Maintenance via IoT
Easy-to-Use Graphic Interface

3 **Future-Ready Digital Power Amplifier**
Clean and crisp Signal via Digital Input
Highest Efficency & Scalability
Intelligent Power Saving Mode

Scan to learn more about our new
Shaker-Series iMPULSE X-Wings35™

Bruker alicona

Maximize turbine safety and efficiency!

Cooling Hole Inspection with Bruker Alicona: Achieve higher efficiency, lower fuel consumption, and maximum safety.

Our fully automated inspection technology ensures:

- **Position**
- **Diameter**
- **Funnel geometry**
- **Cylinder length**

Download now >>>

Unlock the full potential of your turbine! Download the white paper on quality assurance in aviation now.

alicona.com/aerospace

// JOANNA BAILEY

Stations in t

// High Altitude Platform Stations, such as Aalto's Zephyr will stay aloft in the atmosphere for extended periods and provide communications and observation services *(Photo: Aalto)*

The first operational high altitude platform station is taking its place in the stratosphere after years of testing

he sky

Developing a new type of aircraft is always fraught with challenges. But when that aircraft is intended to fly in the stratosphere for months at a time, it's a whole different set of problems.

> ***"We can do long-duration tests of the components, and also cycle the pressure and temperature variations"***
>
> **ED TOWNSHEND, FLIGHT TEST LEAD ENGINEER, PHASA-35**

For companies working to bring high-altitude platform stations (HAPS) into service, there is no well-trod pathway. Touted as an elegant solution to high-resolution surveillance, communications, and environmental monitoring in difficult-to-reach parts of the world, HAPS has been recognized by the World Economic Forum as a critical emerging technology.

But testing a HAPS aircraft is nothing like testing a conventional aircraft or even a satellite. These aircraft face extreme environmental conditions, low air density and a completely different aerodynamic regimen in a part of the atmosphere that is less understood.

Despite the immensity of the challenges HAPS present, the opportunities are great and so a handful of companies are striving to develop a solution. While technical and regulatory issues still need to be overcome, advances in solar power, AI-driven flight management, and lightweight materials are pushing HAPS closer to large-scale deployment.

GROUND TESTING

Naturally, any HAPS vehicle will undergo the usual simulation, architecture and modeling well before production. Once the design is locked in, engineers must ensure every part of the aircraft and its components can withstand stratospheric operations.

Thermal vacuum chambers are needed to replicate the extreme conditions HAPS will experience. Widely used in the space industry, these chambers allow an aircraft's components to be tested in environments that are equivalent to those in the stratosphere.

"It's an essential bit of kit for what we do," says Graham Holland, chief technical officer at Prismatic, a subsidiary of BAE Systems, which is developing the PHASA-35 HAPS. "We can't just go to a normal test house, because the standard aerospace test chambers don't go as cold and as high in altitude as we need."

"We can either run sections of the aircraft or entire subsystems inside there," explains Ed Townshend, flight test lead engineer for PHASA-35. "We can do long-duration tests of the components, and also cycle the pressure and temperature variations to replicate fully the sort of environment it's going to be subjected to."

Some pre-flight testing is more familiar, such as stress tesing, which has seen more than one broken wing in

2

2 // The Zephyr completed its first stratospheric flight test from its purpose-built facility in Laikipia County, Kenya last month *(Photo: Aalto)*

1

1 // The Hawk30 / Sunglider HAPS was developed by AeroVironment and HAPSMobile's to test straatospheric unmanned aircraft systems *(Photo: NASA / Carla Thomas)*

3 // The Zephyr HAPS with its 25m (82ft) wingspan emerges from a hangar *(Photo: Aalto)*

conventional aircraft. For HAPS, with zero rivets and a bonded construction, testing its integrity is essential.

"Every airframe is tested and loaded up to more than 2*g* to validate the quality, especially of the bonding," explains Pierre-Antoine Aubourg, chief technical officer at Aalto, the Airbus subsidiary that oversees Zephyr HAPS.

"We will do this until we are fully convinced of the maturity of the supply chain."

But have any wings been broken? "Yes," says Holland. "When you're trying to push the limits of what is possible, you need to understand the materials you are working with.

"We do ultimate load testing and then go even further to understand the failure mechanisms because that's hugely important as part of that understanding."

WEATHER WATCHERS

Before a HAPS can leave the ground, the conditions need to be right. Wind speeds of more than 20 to 30 knots or low cloud can prevent a launch. This means having knowing the meteorological conditions at the launch site and along the flight path.

"We set up a dedicated team looking at weather forecasting to interpret all the data according to our specific need," says Aubourg. "We look at everything from launch location to global weather patterns to ensure we have access to the stratosphere without risk."

The Prismatic team works with the Met Office in the UK for weather reporting and has

HAWK LIVES ON TO SUNGLIDER

HAPSMobile was launched in 2017 by Japanese mobile telecommunications business Softbank. In 2018 the company partnered with US aerospace and defense firm AeroVironment on a US$65 million program to develop a solar-powered, high-altitude, unmanned aircraft and associated ground control stations.

The Hawk30 was a successor to the NASA Pathfinder and Helios stratospheric drone programs worked on by Aerovironment. Hawk30 made its first test flight in 2019 above Hawaii.

Hawk30 was rebranded as Sunglider, with a military variant called Horus A, and HAPSMobile absorbed into its parent company. The company has continued to flight test the aircraft, most recently during October 2024 in New Mexico, USA working with AeroVironment and the US Department of Defense. Sunglider has a 78m (255ft) wingspan and a payload capacity of 75kg (165 lbs).

a professional meteorology team on hand for interpretation. In addition, they use Honeywell's High Altitude LiDAR Atmospheric Sensing (HALAS), combining data from this and other weather models to get the most accurate prediction of conditions.

Needing to be very efficient on the climb, PHASA-35's first stratospheric flight in 2023 was undertaken with low airspeed. This meant it was more susceptible to the wind, and it was pushed back substantially during the flight. "In that first flight trial, we were flying backward for around 70km," notes Holland.

But thanks to extensive weather data, it wasn't a surprise and had been planned for before the aircraft left the ground. "We had been validating the models such that we can predict performance, the meteorology, the location, the drift back," explains Townshend. "We knew exactly how far we were going to drift back and we had a very good prediction of what was going to happen."

FLIGHT TESTING

Being some of the first to extensively explore the stratosphere means HAPS companies are collecting large quantities of data on the environment. With more than 5,000 flight hours in the upper atmosphere, Aalto has begun to make some interesting discoveries.

"We can characterize gravity waves in the stratosphere and use them like a surfer," says Aubourg. "It means we can optimize our trajectory and our transit in the stratosphere."

While deep knowledge of the upper atmosphere is still a work in progress, survival at these extreme altitudes is not such an issue. "It's very benign in the stratosphere, the winds are very low," says Holland. "The transit is the most difficult bit. We see it as the highest risk portion of any of our flights."

By their nature, HAPS are very lightweight aircraft. The Zephyr has a maximum takeoff weight (MTOW) of around 75kg (165 lbs), with 5kg (11 lbs) of payload. The PHASA-35 is heavier at 150kg (330 lbs) MTOW, but with 15kg (33 lbs) of payload.

Both are primarily made from carbon-fiber composite with most of the weight coming from the lithium-ion batteries, putting the aircraft at risk of buffeting and structural damage in the troposphere.

"Our biggest challenge to entering into mass operation is to ensure survivability during access to the

4

4 // Several startups, such as Halo Space are developing passenger-carrying capsules to provide stratospheric flights for tourists *(Photo: Halo Space)*

BALLONS OFFER ALTERNATIVE ROUTE TO STRATOSPHERE

Gliders aren't the only type of aircraft being developed for use in the stratosphere. Various designs of balloon are also being investigated by engineers in startups around the world looking to establish persistent aerial platforms in the sky. Balloons have been regularly used for research and surveillance purposes for many years and offered the first routes to the sky more than two hundred years ago.

Despite the failure of the first major modern ballon project, the Google-funded company Loon was shut down in 2021, companies such as New Mexico-based Sceye and UK-based Avealto are testing blimp-like designs. Like Loon and glider-like HAPS these are designed to carry communications payloads. But perhaps the most ambitious projects are those that aim to carry passengers. Companies including Spain's Halo Space and France's Stratoflight are building and testing prototypes.

While not strictly a HAPS, these designs use balloons to lift capsules into the stratosphere and then a braking system to control descent.

6

5

5 // ELVIS - Electronic Launch and Vehicle Integration System enables Zephyr to gain the required inertia before launch

6 // Aalto is calling its launch sites, like this one in Kenya, Aaltoports *(Photos: Aalto)*

stratosphere and recovery," explains Aubourg. "We had several learning experiences in the past, where we encountered some early termination of aircraft due to thermal activity and turbulence."

In response to this, Aalto undertook a complete redesign of Zephyr's flight control laws, tailoring to the elasticity of the aircraft and giving more control during turbulence. Testing in 2023 over half a day proved the new configuration, with Zephyr successfully controlled at very low altitudes of around 6,000 ft.

"As a result, we were able to significantly extend the flight domain and survive in situations where in the past, we could have lost the aircraft," explains Aubourg.

Test flights are a great opportunity to understand HAPS better, and the Aalto Zephyr's latest flights have been fully instrumented with accelerometers, pressure sensors and other equipment. "It helps us understand load distribution on the aircraft, the behavior, and allows us to validate our models," says Aubourg.

"The wonderful thing about HAPS aircraft is that your missions are substantially longer than test flights with commercial aircraft," notes Holland. "We can do a huge amount of data collection because we're up for so long."

OPERATIONAL READINESS

In early 2025, Aalto took Zephyr on a milestone 13-day flight equipped with direct-to-device (D2D) 4/5G connectivity payload, developed in-house at its Farnborough facility. As well as testing this technology, the flight validated its improvements to the flight envelope and put new power conservation strategies through their paces.

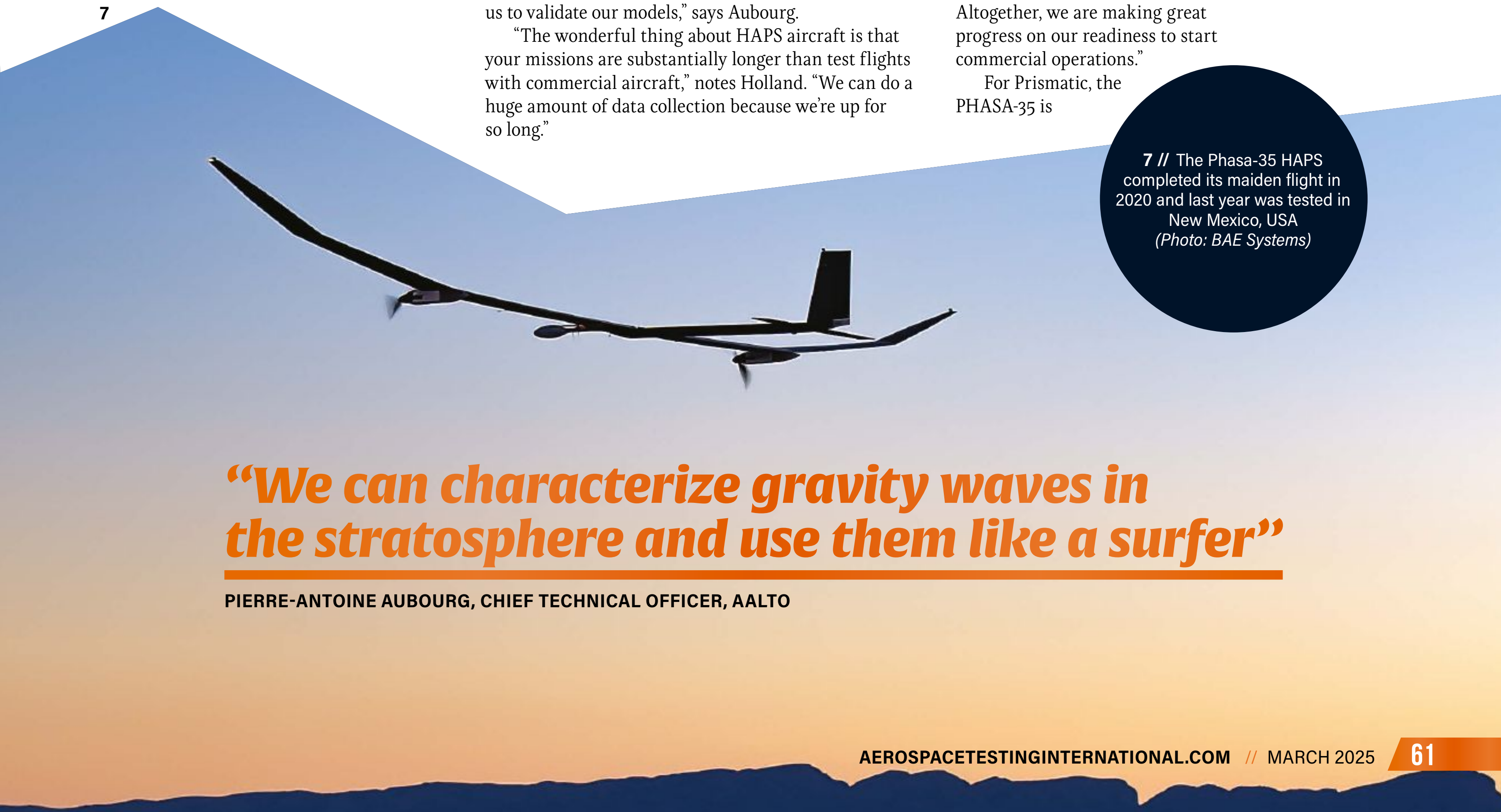
But the most remarkable element of Zephyr's first 2025 flight was where it was launched from. For the first time, Zephyr took off not from Arizona, but from Laikipia County in Kenya, from the company's own 'Aaltoport', the world's first purpose-built HAPS facility.

"Being able to launch from our base in a place that can offer seven to eight months access to the stratosphere is a significant step forward," says Aubourg.

"Over the last year, we increased the maturity of the aircraft and its ability to survive adverse conditions, and now we will have more launch opportunities. Altogether, we are making great progress on our readiness to start commercial operations."

For Prismatic, the PHASA-35 is

7



7 // The Phasa-35 HAPS completed its maiden flight in 2020 and last year was tested in New Mexico, USA *(Photo: BAE Systems)*

> ***"We can characterize gravity waves in the stratosphere and use them like a surfer"***
>
> **PIERRE-ANTOINE AUBOURG, CHIEF TECHNICAL OFFICER, AALTO**

> **"There's lots of work ongoing with regulators and the industry trying to figure out the route forward"**
>
> **GRAHAM HOLLAND, CHIEF TECHNICAL OFFICER, BAE SYSTEMS**

reaching a key transitional phase towards operational readiness. Under test in recent flights has been its Block 10 aircraft with a limited solar array. Coming in 2025 will be Block 20, covered top to tail in solar panels and equipped with next-gen power systems. The new model has more than twice the onboard solar power generation and storage capacity than the current version.

"We know we can fly in the stratosphere. We know it works as we intend it to, and now we want to be able to do that as a sustained flight," explains Holland. "That's the target for this year, is to prove out that next-gen system on multi-day flights."

With no defined route to certification of these aircraft, companies like Aalto and Prismatic must obtain permission for every take-off. Being able to certify HAPS would remove this barrier and make flights much easier to schedule. "We will not have commercial operation without certification," says Aubourg. "We're working with the UK CAA to define a certification pathway, and hope to conclude this by next year. That will simplify our life."

"There is no certification base we can pick up on, but we need to get there," notes Holland.

"There's lots of work ongoing with regulators and the industry trying to figure out the route forward. Do we need a formal type certificate? I don't think we have an answer to that yet."

Following the 13-day Kenya debut, Aalto's next campaign plans to push endurance limits even further. Ultimately, the company has set its sights on fully autonomous continuous operation for over 100 days. This would be a record, already held by Zephyr with a 64-day flight in 2022. But Aalto insists they are not just chasing accolades, as future flights will focus on demonstrating the full end-to-end capability for future customers.

Everything these groundbreaking aircraft have achieved to date has been done with existing battery technology. As that technology evolves, HAPS could ultimately be even more capable.

"Any saving on the weight of the battery can be used for something else: to fly longer, higher altitude or with bigger payloads," says Aubourg. "We are pushing our supplier to improve all the time." \\

8

9

8 // Development of PHASA-35 has taken place in Farnborough, UK

9 // Phasa-35 has a wingspang of 35m (115ft) *(Photos: BAE Systems)*

10

10 // The next version of Phasa-35 to be flight tested is fitted with more solar panels than previous iterations *(Photo: BAE Systems)*

safety in test > safety in flight TEST-FUCHS

BEST-IN-CLASS TEST SYSTEMS & GSE

With decades of experience in aerospace engineering (civil and defense) plus the ability to utilize engineering, service and production resources from 11 locations worldwide, we are ready to exceed your expectations!

Scan now and discover our wide range of products and services!

MEET US!

AVIATION WEEK
MRO
AMERICAS

April 8-10, 2025
Atlanta, GA, USA
Booth #4171

WWW.TEST-FUCHS.COM

We test it!

ets european test services

www.european-test-services.net

European Test Services (ETS) B.V. maintains and operates the environmental test centre of the European Space Agency (ESA) located in The Netherlands.

Aerospace Equipment Testing

Over the years ETS has proven its competence and experience within Aerospace Industry.
The large variety of facilities enables ETS to test small units up to large and complex structures.

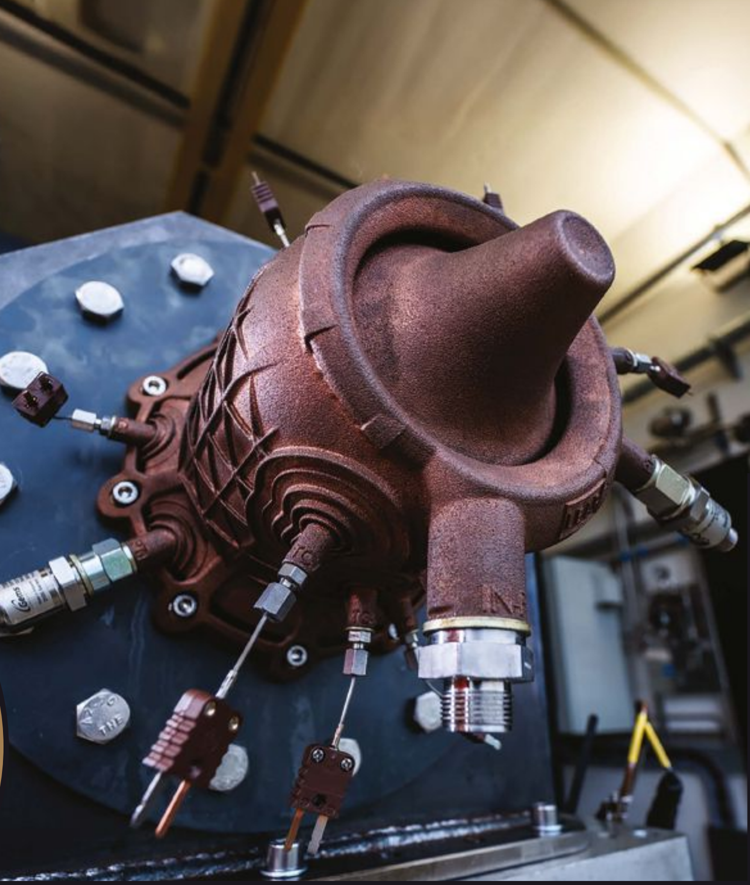
European Test Services (ETS) B.V. · Keplerlaan 1 · NL-2201 AZ Noordwijk · Phone: + 31 71-565 59 69 · E-mail: info@european-test-services.net

// GRAHAM JARVIS

AI revives the AERO

The use of large computational engineering models, AI and 3D printing is enabling R&D into an engine design previously abandoned as too tough to make

SPIKE



1 // Leap71's four day test campaign for its aerospike prototype engine was done at Airborne Engineering in Westcott, UK during December 2024 *(Photo: Leap71)*

3 // The aerospike engine was printed using a laser powder bed fusion process *(Photo: Leap71)*

There are several aerospike engines in development and testing around the world. For example, engineers at Dubai-headquartered computational engineering company Leap 71 successfully test-fired their aerospike engine during December last year for four days.

The hot-firing took place at Airborne Engineering's test site in Westcott, UK and produced 5,000N (1,100 lbf) of thrust, powered by cryogenic liquid oxygen and kerosene. According to Airborne the design for the engine was "generated autonomously by the latest generation of Noyron, its large computational engineering model."

Leap 71 claims that AI was used to develop the thruster in a matter of weeks. The prototype was "manufactured as a monolithic piece of copper through industrial 3D printing, and put on the test stand, where it worked successfully on the first attempt."

Traditionally, the design and testing and manufacturing of aero-engines takes many years – involving repeated modeling, testing, revision, prototyping and analysis to ensure that an engine is going to meet requirements. Leap 71 appears to have disrupted this model with its aerospike engine test. Leap 71's successful test also puts it among a small group that

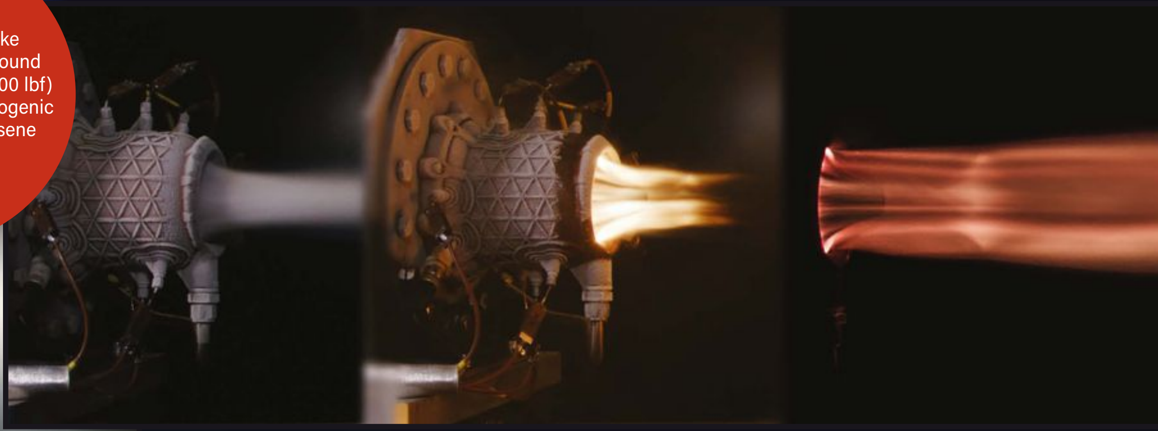
TWO WAYS AI IS SPEEDING UP SPACECRAFT DEVELOPMENT

AI is increasingly being used in the development of propulsion systems for launch systems and spacecraft, helping engineers work out if vehicles can survive the harsh environments using ground testing first.

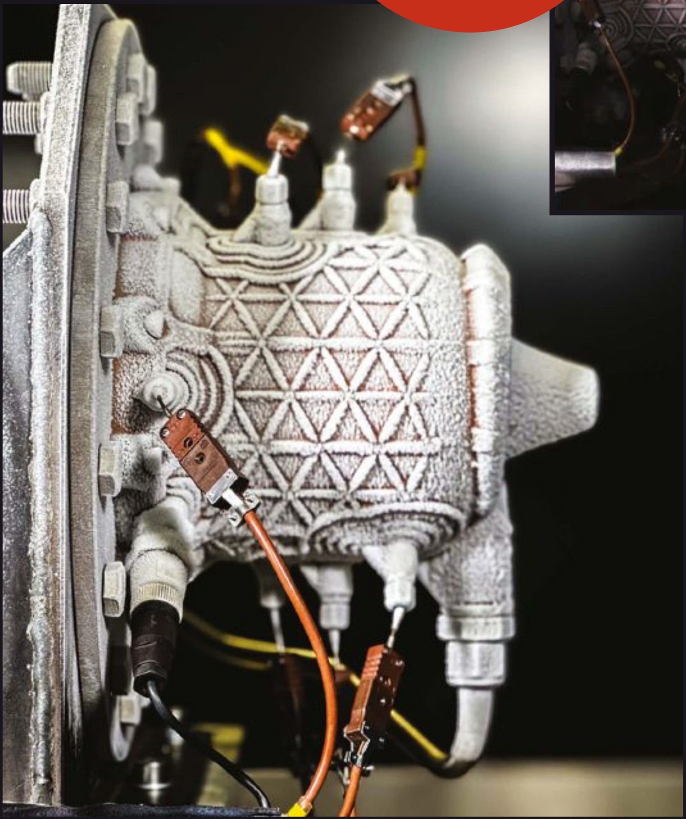
By leveraging AI, it becomes possible to efficiently analyze the vast amounts of data generated from electrical, mechanical and environmental tests. Then once in operation, satellites for example are equipped with hundreds of sensors, enabling condition monitoring.

An AI solution from IT company NEC called Invariant Analysis collects and analyses large volumes of time-series data from numerous sensors installed in large and complex systems. It models the invariant relationships between sensors that typically exist during normal operation. By comparing the predicted data changes with the actual data, anomalies can be detected at an early stage, helping prevent serious accidents and improving maintenance efficiency.

By converting internal documents, image, and audio data into a database and using generative AI, access to internal knowledge is made easier for less experienced engineers with limited foundational knowledge. This approach supports the transfer of technology and expertise from veteran engineers, facilitating the inheritance of their skills and know-how.



2 // Leap71's aerospike prototype during the ground test produced 5,000N (1,100 lbf) of thrust, powered by cryogenic liquid oxygen and kerosene *(Photo: Leap71)*



> **"Aerospikes adjust their exhaust flow based on external pressure"**

over the last 30 years have mastered the complex challenges of the aerospike engine design, alongside teams from NASA, USA-based Stoke Space, India's SpaceFields, Spain's Pangea Aerospace and Germany-based Polaris Raumflugzeuge (Polaris Spaceplanes).

DISRUPTIVE ROCKET ENGINES

Engineers at Pangea Aerospace claim to have "designed, manufactured and hot-fire tested the most disruptive rocket engine in the world," solving the historical problems of the aerospike: cooling, weight, and manufacturing costs.

Working with the aim of reducing the environmental impact and cost of space launches, Pangea says its aerospike engine will increase the amount of payload put into orbit per launch and improve carbon neutrality and offers "a shorter time to market without investing into a complex and costly engine program".

Achieving firsts is part of the race to develop aerospike engines. For example, Polaris recently went a step further when testing its aerospike engine – achieving the first flight of its MIRA II aircraft on October 29, 2024 from Peenemünde Airport, Germany over the Baltic Sea, around 3km (2 miles) from the ground station. The day began with a rolling tarmac test of engine before the test flight.

Using an autopiloted pre-determined flight path, the aircraft powered by its kerosene jet turbines took to the air before igniting its AS-1 LOX (liquid oxygen) kerosene linear aerospike rocket engine for three seconds – making it the first firing of a 1kN aerospike rocket engine in flight. Unlike Mira 1, it returned to their airport and landed safely after covering a distance of 10km (6 miles).

AEROSPIKE FEASIBILITY

These projects and others show it is possible to design, test, and develop aerospike rocket engines. However, their development is not new. Kara Mohebian, the head of propulsion at Polaris says they have been studied since the 1950s as an alternative to traditional rocket nozzles. They are different to traditional rockets because they invert the bell-shaped rocket nozzles that have been commonly used in rocket designs for decades.

Mohebian explains: "Unlike bell-shaped nozzles, aerospikes adjust their exhaust flow based on external pressure, making them highly efficient across different altitudes.

"Early tests were conducted in the Cold War era, and significant development took place in the 1990s with various experimental programs.

"Although aerospikes are mainly designed for space applications, they have potential terrestrial uses, such as hypersonic aircraft. The main challenge has always been cooling and structural complexity, but recent advancements in materials and manufacturing are making their practical use more feasible."

Lin Kayser, founder and CEO of Leap 71, adds that aerospikes were primarily developed by Rocketdyne and NASA as a

4 // Researchers from the University of Sheffield used a large computational engineering model to design and test engines in just two weeks, overseen by Alistair John, deputy director of aerospace engineering (below) *(Photos: University of Sheffield)*

> **“The software enables you to design, use rapid prototyping, test and iterate quickly”**

more efficient alternative to traditional bell nozzles: “The key advantage is altitude compensation, maintaining high efficiency from ground level to the vacuum of space, which sets them apart from conventional thrusters.”

However, teams have struggled for many years to make aerospike engines work. The Space Shuttle was supposed to use aerospike engines, but engineers lacked the tools and the production methods at the time to make it happen. Subsequently, they couldn’t “overcome the challenges of that engine, most notably cooling the spike, which sits in the middle of the exhaust gas,” says Kayser.

As for the advantages of aerospikes, Apurwa Masook, the founder and CEO of India-based propulsion-systems company SpaceFields, says they are most relevant for

AI IN AEROSPACE PROPULSION SYSTEM DESIGN

Computational Engineering is unlike the AI used in Large Language Model (LLM) such as ChatGPT and is a sophisticated algorithmic model that encodes engineering logic, physics, manufacturing constraints and practical aspects from field tests. Software company Leap 71 built its first Large Computational Engineering Model to demonstrate how it can improve the design, testing and development of modern aerospike engines. Lin Kayser, a co-founder of the company calls it “the first AI that builds machines”.

Kayser says that Leap 71’s approach could be applied to any field of engineering: “We have used it for many things, including electric motor design, micro-mechanics, and we have done extensive work on heat exchangers, including a concept for a hypersonic pre-cooler.”

Alistair John, programme lead for Aerospace Engineering at the UK’s University of Sheffield, has worked closely with Kayser’s team. He says, “Leap 71 are extending their software to other aspects of propulsion systems such as gas generators, turbopumps, and heat exchangers. Eventually, they may be able to design a complex full rocket engine.”

Beyond aerospike engines, Apurwa Masook, founder and CEO of SpaceFields, which launched India’s first aerospike engine on 11th September 2024, says AI assists in designing hybrid rocket motors for predicting fuel regression rates. Artificial intelligence is also used in liquid rocket engines for optimizing injector patterns and combustion stability, and for enhancing hypersonic flow modelling ramjets and scramjets.

Masook says, “The integration of AI into these systems is paving the way for next-generation propulsion technologies. AI is instrumental in optimizing thrust vector control mechanisms, improving insulation durability under extreme conditions, and refining nozzle geometries for superior performance.”

5 // SpaceFields test fired its aerospike engine in September 2024 in India *(Photo: SpaceFields)*

space applications, but that technical challenges and limited funding has disrupted their deployment. Masook says, "They are especially important for single-stage-to-orbit applications, but there are interesting applications in atmospheric flight for combined cycle engines in hypersonic aircraft".

ADDITIVE MANUFACTURING

Alistair John, program lead for aerospace engineering at the University of Sheffield in the UK says the renewed interest in aerospikes is partly thanks to additive manufacturing, which allows for the parts to be made more easily. He adds that aerospikes are related to rotational engines, which have also captured the interest of NASA recently, and are related to them.

Aerospikes use atmospheric pressure to give optimal nozzle expansion, allowing them to maintain efficiency at different altitudes. Traditional rockets tackle this by having different stages and tend to have much larger nozzles. With aerospikes, it is possible to have a smaller nozzle and to have fewer moving parts for thrust vectoring. Yet they are hard to make because of the difficulties in keeping them cool and prevent them from melting.

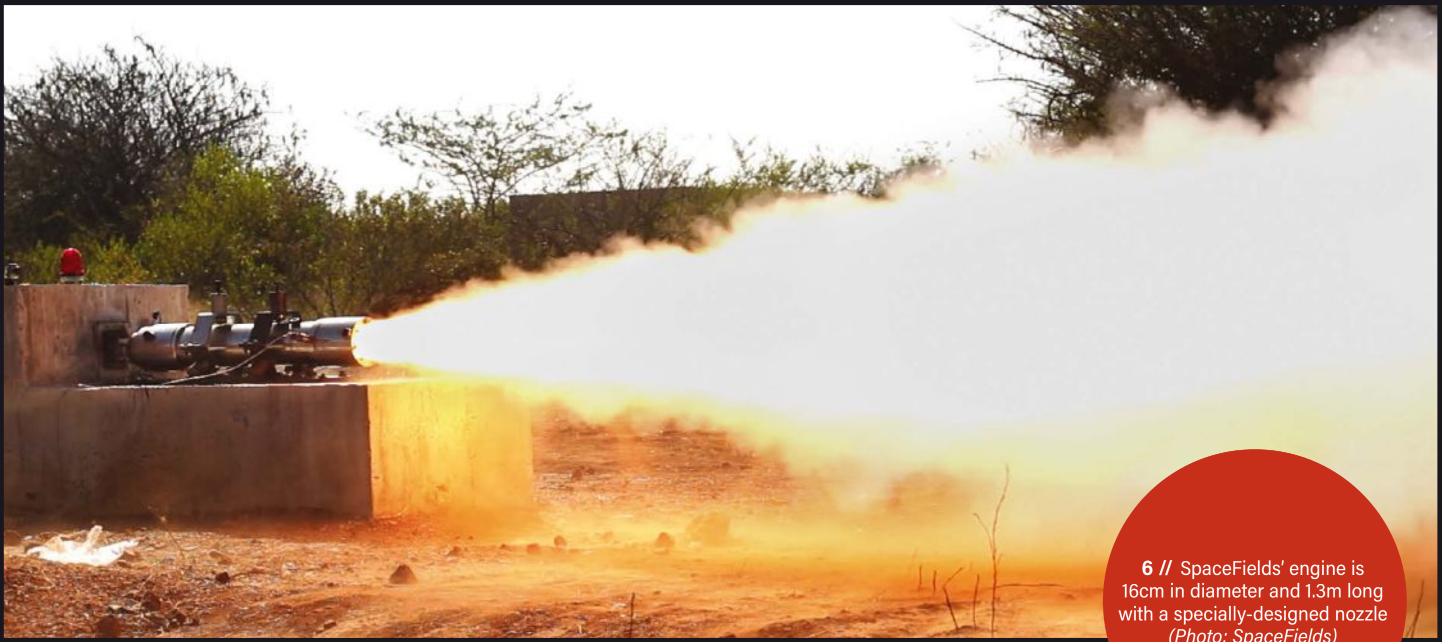
Additive manufacturing and computational engineering help to make the complex internal geometries of an aerospike engine cool. "With Leap 71's software you can also iterate rapidly and make the geometries more easily, allowing you to remake and redesign parts quickly," he says.

FASTER DESIGN

Advanced computational models make it easier to update a design, yet the key to that remains testing. Not everything can be done on a computer to find out whether an aerospike design works or not. Data from real-world testing allows for the modeling to be updated to be more accurate. "Software enables you to design the geometry, you use rapid prototyping, then test and get the data quickly, so you can begin the next iteration," says John, who adds that computational engineering and AI can reduce the amount of manual CAD.

John also believes it is important to embed engineering experience into the model. This means that the process is not entirely hands-off. However, it is possible to code engineering knowledge into the software to capture it. This knowledge can then be incorporated into future design iterations of, for example, an aerospike engine.

Mohebian says, "Large-scale computational models are one of many tools in the propulsion development process, allowing engineers to simulate real-world conditions before building expensive prototypes, reducing testing



6 // SpaceFields' engine is 16cm in diameter and 1.3m long with a specially-designed nozzle *(Photo: SpaceFields)*

> "We train AI models on experimental data from Ballistic Evaluation Motors, strand burn tests, and cold flow testing"

costs and iterations. But simulation results must always be verified using other engineering methods."

She says computational fluid dynamics (CFD) models are also essential for improving designs before real testing of flow thermal dynamics and thermal loads. The use of AI-driven CFD and Finite Element Analysis (FEA) simulations enables the further acceleration of iterative design loops.

Masook explains, "At SpaceFields, we train AI models on experimental data from Ballistic Evaluation Motors, strand burn tests, and cold flow testing with Schlieren imaging. We have developed an extensive in-house dataset comprising hundreds of test results, allowing us to fine-tune predictive models for enhanced accuracy in propellant performance characterization, failure detection, and engine optimization."

A FUNDAMENTAL SHIFT

Kayser describes computational engineering as a fundamental paradigm shift.

Most engineering projects work using a visual approach, "where their output is a drawing of the thing they envision." Computational engineering moves this work to a software-driven approach, where you automate repetitive tasks and improve on previously encoded approaches through a collective team effort. This requires a new way of working that will be transformative for anyone who applies it consistently.

As for the prospects of aerospike engines themselves, Mohebian believes they are promising for next-generation propulsion systems. However, they do need to be thoroughly evaluated for safety, reliability, and performance. This will include subsystem testing, ground-based static firings to analyze thrust, cooling, as well as efficiency and high-altitude test flights using experimental vehicles.

A combination of modern engineering techniques and rigorous real-world validation could enable aerospike engines to enter service as propulsion systems for spaceplanes. They offer valuable advantages for future space exploration and high-speed terrestrial propulsion systems. More than ever before aerospikes have a future – thanks to the advent of AI, machine learning and large computational engineering. But, much also depends on whether these programs can keep their investors happy. Without finance, nothing will fly. \\

IMAGES: anantachat, Alex @ADOBE.STOCK.COM

ONBOARD
DATA
ACQUISITION

REDEFINE
POSSIBLE

with
SLICE6 AIR

SLICE6 AIR
DTS

The industry's smallest Ethernet-based DAU expands your flight testing capabilities, plus reduces test setup times and costs.

- SWaP-Optimized
- Universal Analog Sensor Support
- Real-Time Streaming and/or Onboard Recording
- 4-6 Week Lead Times

Contact sales@dtsweb.com to learn more

DTS
A VPG Brand

© 2025 VPG - All Rights Reserved | DTS - Diversified Technical Systems is a VPG Brand
Puma Drone Photo Courtesy of AeroVironment, Inc.

HIGHEST RESOLUTION
FOR THE HIGHEST SAFETY

HD-CR 35 NDT
COMPUTED RADIOGRAPHY SYSTEM

- ✓ Unique 30 µm basic spatial resolution
- ✓ Scans flexible imaging plates up to 35 cm in width
- ✓ Widest range of applications thanks to TreFoc Technology
- ✓ Intuitive handling & easy transition from film
- ✓ Portable and rugged (17.5 kg)

AEROSPACE STANDARDS MEETS

30 µm
basic spatial resolution
TreFoc
TECHNOLOGY
100 µm
basic spatial resolution
80 µm
basic spatial resolution

D-DR 1025B/2329 NDT
FLAT PANEL DETECTORS

- ✓ 10 x 25 / 23 x 29 cm active area
- ✓ Internal shielding for use up to 450 kV
- ✓ Stationary and mobile operation (WLAN/battery)

D-DR 7 NDT CMOS DETECTOR

- ✓ 3.6 x 2.6 cm active area
- ✓ Ultra-high resolution
- ✓ Ideal for small welds and pipes

25 µm
basic spatial resolution

With DÜRR NDT's high-resolution digital X-ray systems, you can perform even the most demanding inspection and MRO tasks reliably and with ease. The powerful X-ray inspection software D-Tect X supports you with all the tools you need to work with industry standards (ASME, ISO, Nadcap, ...) and provides a time-saving workflow.

Arrange a free demonstration and convince yourself.

Digital Intelligence – Ready to Change.
www.duerr-ndt.com / info@duerr-ndt.com

DÜRR
NDT

// BEN SAMPSON

Robotics and software INNOV

ATION

Advanced robotics and artificial intelligence can provide automation solutions that meet NDT's exacting requirements

Nondestructive testing in aerospace is evolving rapidly, driven by the needs for higher accuracy and faster inspection cycles, as well as a drive to improve repeatability in manufacturing.

Simultaneously meeting commercial objectives, sustainability, and climate change goals while ensuring safety and reliability is a tough challenge for aerospace companies. Faced with these and other pressures, many aerospace nondestructive testing (NDT) practitioners are turning to integrating robotic systems with advanced software in order to refine and automate inspection processes.

UK-based research and technology company TWI, a subsidiary of The Welding Institute is perhaps best known for the engineering training it provides. One of TWI's core competencies is materials performance for which it has a center of excellence at its Technology Centre in Port Talbot, Wales.

Nathan Hartley is the section manager for NDT research and technology at TWI's Technology Centre. He says, "We are supporting our members by helping them improve inspection resolution and accuracy, to reduce inspection and analysis times, to improve the reliability and repeatability of those inspections."

Saving time while improving accuracy and reliability are the stated aims of almost all automation projects. Likewise, the key question before any project is started is how much time will automating a process save. How much more accurate can the use of robots and software make measurements?

"It depends. On the component, on the materials, what you're looking for, the resolution and the size of defect you're trying to find," says Hartley. "A recent test piece given to us was a curved carbon fiber winglet component. We achieved a nine times reduction in time to inspect that component with robotics compared to the manual inspection. That gives you a rough idea of what's possible."

> ***"Innovation only seems to make inspection harder"***
>
> **NATHAN HARTLEY, SECTION MANAGER FOR NDT R&T, TWI TECHNOLOGY CENTER**

ROBOTIC CELLS

TWI operates two large industrial robotic cells dedicated to aerospace component inspections. The systems are equipped with KUKA robotic arms mounted on tracks. This extends the inspection volume and allows for flexible configurations of the equipment.

"We can inspect up to a twelve by three by three-meter volume," says Hartley. "We also have a turntable that is around four meters in diameter with a one-ton weight capacity."

The setup enables the efficient scanning of large or geometrically complex structures, ensuring consistent data collection. The robotic systems also provide an advantage over manual inspection by eliminating variability and increasing repeatability. Where manual inspections can be time-consuming and subject to human error, a robotic system can execute pre-programmed scans with precision. This is especially crucial for applications in the aerospace sector, where defects in composite and metallic structures can compromise safety.

LASER ULTRASONIC TESTING

Laser ultrasonic testing (UT) is an effective NDT solution for inspections that require both non-contact and tracking of complex shaped parts.

The technology uses lasers to generate, and then measure ultrasonic waves in a material. Laser UT is able to remotely generate ultrasound in materials without contact. It also leaves a very small footprint, meaning it can be applied to irregular geometries, and allows access to restricted areas via fibre optics.

R&D on the mechanisms of generation and properties of the ultrasound produced by lasers has been carried out since the 1980s. A technology readiness level of between six and eight has been reached by certain laser UT applications, such as thickness measurement for steel tubes and damage detection of composite aircraft components. Other applications for laser UT include:

- Industrial in-process measurements on hot, hazardous, remote samples which may be moving at high speeds
- High-resolution measurement of small parts
- Inspection of complex structures

TWI is pursuing various laser-ultrasonics projects involving the inspection of friction stir welds, laser material depositing and composite materials.

1 // Robotic NDT systems at TWI enable faster, more precise aerospace inspections

2 // KUKA robotic arms mounted on tracks extend inspection reach and flexibility

EXPANDING ROBOTIC INSPECTION

One of the key drivers of robotic NDT adoption is the increasing complexity of aerospace materials and components.

"As we see more carbon fiber and more additive manufacturing processes being used in aerospace, larger structures with more complex geometries, the much more challenging materials have necessitated the use of robotics," Hartley says. "Innovation only seems to go in one direction from an inspection point of view. It makes it harder."

Glass fiber is notoriously difficult to inspect with ultrasonic testing (UT), because each different layer refracts the signal, while big fibers can cause a lot of noise and a poor signal-to-noise ratio. Aerospace applications also use a lot of honeycomb-type core materials, and ultrasonics don't travel very well through the air.

Some modern fuselages also have sections that use layers of viscoelastic sound-deadening materials, specifically designed to absorb sound. "Inspecting that with sound can present several challenges," says Hartley.

"We have done some work with laser UT. It's an interesting inspection method because it allows very high accuracy. It's non-contact and rapid. We have penetrated some really challenging material, sometimes with acoustic deadening material within it.

"One of the things that's very difficult with laser UT is getting the right balance of energy into the part without damaging it."

TWI's robotic systems are modular and designed to accommodate a variety of NDT techniques. As well as UT, they use phased array ultrasonic testing (PAUT), eddy current testing, microwave inspection, digital radiography, and even laser ultrasonics.

CarestreamNDT

HPX-ARC BENDABLE DR

Bending the Limits of DR.

The INDUSTREX HPX-ARC 1025 PH is a revolutionary, 98 μm bendable digital radiography (DR) design. It conforms to various objects and has the flexibility to go from a flat position down to a 2-inch diameter to get high-resolution images instantly. You get an incredibly simpler workflow and the image detail you need for game-changing speed and certainty, and next level productivity.

With bendable DR technology, customers will realize easier set-up, faster time to image, less dose required to capture images, and instant image processing versus film or CR. Ideal for Aerospace & Defense, the HPX-ARC is field tested and includes a flexible IP67 enclosure to protect against water, liquids, and dust.

INDUSTREX Digital Viewing Software for CR and DR

Operates seamlessly across our ever expanding CR and DR modalities. Easily add any of our digital imaging systems without having to purchase and learn new software. Easy to set-up with a user-friendly interface design to acquire both CR and DR images for detailed analysis.

SCAN FOR MORE INFORMATION

carestream.com/ndt

Carestream NDT and You.
We're Better Together.

Carestream

© Carestream Health, Inc., 2025 CARESTREAM and INDUSTREX are trademarks of Carestream Health.

“Cobots are designed to work next to humans”

NATHAN HARTLEY, SECTION MANAGER FOR NDT R&T, TWI TECHNOLOGY CENTRE

“We are also able to do coupled UT, pulse echo and through transmission,” says Hartley. “Where you have got very attenuative materials, sometimes it is not possible to inspect those with pulse echo. If there’s access to both sides, then we will do through transmission inspection.”

Beyond fixed robotic cells, TWI is also developing mobile and collaborative robotic solutions (Cobots) for site deployable inspections. “Where you have structures that are too large to bring to the robot cell, we can take the robot to the structure instead,” says Hartley.

Cobots offer a significant advantage in a confined or hazardous environment. “They are specifically designed to work alongside humans. You don’t need fixed safety guarding around the outside, and we can work right next to them,” Hartley says.

An example of this adaptability is TWI’s work with large fuselage sections, where automated systems perform ultrasonic inspections at height, reducing the need for scaffolding and manual labor. This improves safety while expediting the inspection process.

3 // Advanced automation improves accuracy and repeatability in defect detection

4 // Cobots enhance safety and efficiency by performing inspections alongside humans

The capability to deploy Cobots in aircraft hangars or production lines also ensures minimal disruption to operations, a key factor in aerospace manufacturing.

SOFTWARE TO ENHANCE HARDWARE

The effectiveness of robotic inspection is determined not just by the hardware but also by the software that drives it. TWI has developed its own custom-built software, the TWI Crystal Software Development Kit (SDK) for NDT robotic inspection applications. The SDK provides an integrated environment for data acquisition, visualization, and analysis.

“The SDK consists of three main layers – a user interface layer, a data layer, and an acquisition layer,” explains Mark Sutcliffe, consultant for NDT Software at TWI. “This approach is very efficient, as it supports rapid application development. In some instances, it may only take a few days to incorporate a new NDT inspection device.”

A key innovation within the software is the ability to merge 3D scanning data with ultrasonic feedback to dynamically adjust the inspection path. “Because this acquisition is independent of the CAD used for path planning, you can also use the UT signal itself as a metrology system,” Sutcliffe says.

This capability is useful when dealing with deviations from nominal CAD models, which is a common issue that occurs in aerospace composite manufacturing. The software’s ability to integrate multiple NDT techniques is also valuable because it allows for data fusion.

So for example, ultrasonic results can be overlaid with digital radiography

COBOTS FOR INSPECTION IN THE HANGAR OF THE FUTURE

One of the leading examples of collaborative robotics applied in aerospace is Airbus’ Air-Cobot.

Originally launched in 2013 and funded by the Aerospace Valley body in southwestern France, the R&D program was lead by consultants Akka Technologies before being absorbed into Airbus’ Hangar of the Future program in 2016.

The Air-Cobot concept uses a wheeled robot equipped with cameras and nondestructive testing sensors. The cobot autonomously moves around an aircraft while it is in a hangar to examine the fuselage for defects. Planned developments included teaming the Air-Cobot up with a drone.

However, the last reported appearance of the Air-Cobot was in 2017 when the robot was donated to the Aeroscopia museum in Toulouse, so it can be used for scanning historical aircraft and research.

Faster, more consistent inspections with the

D-2060 CE

Inspect parts more quickly and comply with industry standards with an automatic double mag shot, adjustable mag shot timer, and machine repeatability.

MAGNAFLUX

Smart UE1 EVO

TESTIA
AN AIRBUS COMPANY

Tougher than ever,
now with enhanced ergonomics!

Smart UE1 EVO
TESTIA
ThicknessGauge
14.13
Retard
19.1
Base de temps
dB 28.0
Gain
Pause
4.28
Appuyer sur Calibrer
Charger
Portes
Calibrer
Pause

Referenced in more than
185 NTMs
to maintain Airbus aircrafts

The newest evolution of Testia's multi-method inspection tool

- Ultrasonic testing
- Thickness gauge
- Clad detector
- Coating thickness gauge
- Eddy current testing
- Galvanometer
- Resonance test
- Conductivity test

Visit the
product page
on testia.com

5 // TWI's Port Talbot site develops and applies novel NDT methods

6 // AI-driven robotic inspection aims to revolutionize autonomous defect detection

> “One of the challenges is the lack of data ”
>
> **MARK SUTCLIFFE, CONSULTANT FOR NDT SOFTWARE, TWI**

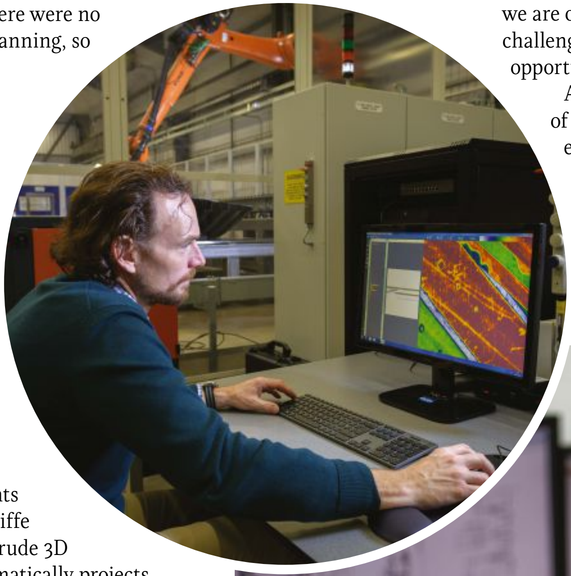
images or eddy current scans, creating a comprehensive picture of component integrity.

CHALLENGES IN PATH PLANNING

Path planning remains a significant challenge in robotic NDT, says Sutcliffe. “When we first started development into robotic NDT, there were no tools available for us to do path planning, so we had to build it from scratch.

“There still aren't that many options for NDT solutions. The typical approach is to take the CAD of the component, break this down into a series of manageable areas, and overlay a raster pattern.”

However, this method does not always allow for defect-oriented probe positioning. To address this, TWI has developed a semi-automated process that does not require expert robotic programming knowledge.



“The user touches several points on the surface with a robot,” Sutcliffe says. “The SDK then generates a crude 3D CAD of that component and automatically projects a raster path onto that surface. The user selects a preferred orientation, and from there, scanning starts immediately.” This automation significantly reduces the time required to set up inspections, improving overall efficiency.

AI FOR DEFECT RECOGNITION

Artificial intelligence (AI) and machine learning (ML) are starting to play a role in the implementation of NDT technologies, particularly in areas such as defect recognition and path planning. However, challenges remain before its use can become widespread.

“One of the challenges with NDT and applying AI to it is the lack of training data,” says Sutcliffe. “Nine times out of ten, you are inspecting parts expecting them to be good. So, it is very difficult to get access to sufficient training data.”

Despite this, AI-driven inspection planning is a promising area. Sutcliffe says, “The idea is to have a robotic platform that drives up to a structure, performs the inspection autonomously, and applies self-driving AI algorithms to that process. That's where we see the shorter term goal for AI application.”

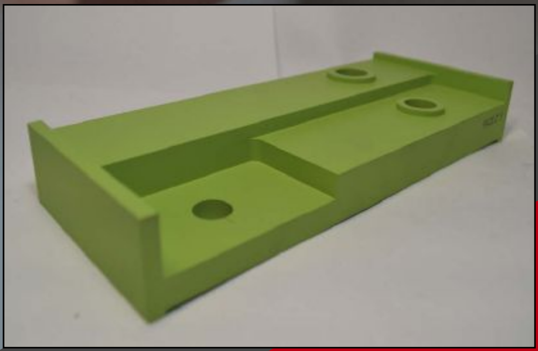
With ongoing developments in AI, automation, and new NDT techniques, the future of aerospace inspection is increasingly defined by robotics and intelligent software. Hartley says, “We like to think that we are on the cutting edge of research at TWI. The challenges ahead are significant, but so are the opportunities.”

As TWI expands its capabilities, the combination of robotics and sophisticated software solutions ensures aerospace manufacturers can meet stringent safety and quality requirements efficiently. This continuous innovation is positioning robotic NDT as an essential tool for the next generation of aircraft and spacecraft manufacturing. \\

7 // TWI's custom-built software optimizes data acquisition and defect recognition

IMAGES: VINA, aapsky, gen_A, Sergey Ryzhov, Khaligo & Pixel_B - ALL @ADOBE.STOCK.COM

0.005
0.005
3/16
0.010
0.025
0.025
0.030



About AEROFAB NDT

Founded in 2013, Aerofab NDT is a leading manufacturer of Non-Destructive Test(NDT) equipment supporting the Aerospace industry.

Our customers include **AAR Aircraft MRO**, **Airbus Canada**, **BAe**, **Blue Origin**, **Boeing**, **Bombardier**, **Embraer**, **Lot AMS**, **Lufthansa**, **SpaceX**, **Testia**, and the **United States Air Force** to name a few.

Aerofab NDT specializes in manufacturing custom NDT support tooling for Aircraft and Space applications which include Eddy Current probes, Ultrasonic Transducers, Reference Standards and Composite Standards. We can offer custom calibration standards and thickness gauges specifically designed around customer requirements.

We are a leader in manufacturing alternate products for hard to find or obsolete NDT tooling and equipment as published in many Airbus and Boeing NTM procedures. We have experienced staff who can offer expert solutions and support for your NDT trouble spots. We offer custom in house EDM(Electrical Discharge Machining) solutions tailored to customer applications.

Contact us at sales@aerofabndt.com
for all your NDT tooling needs.
AEROFAB NDT
Phone: 253-395-8706
8649 S. 212th St. Kent, WA. 98031
Web: www.aerofabndt.com
Email: sales@aerofabndt.com

NDT

// ABIGAIL WILLIAMS

Everest Mentor Visual iQ+

TESTING *without* BREA

KING

Nondestructive testing is a key tool for test engineers examining the quality and performance of parts and materials in aerospace

In recent years, nondestructive testing technology has grown more important in the aerospace sector. An increasing number of companies view it as a key element of testing in development, manufacturing, maintenance and inspection processes.

So, what are the different types of traditional and advanced methods and nondestructuve testing (NDT) processes? What are the key recent innovations and how might emerging technologies like AI, machine learning, or robotics influence the future of use of this technology?

COMMON METHODS

The technologies and methods used for the NDT of aerospace parts are broad but can be grouped into several categories. These include: Penetrant Testing (PT), Ultrasonic Testing (UT), Radiography Testing (RT), Infrared Thermography (IRT), Visual Testing (VT), Eddy Current Testing (ET) - which uses an electromagnetically charged probe to induce eddy currents in the tested material to pick up surface and near-surface defects in conductive materials and Magnetic Particle Testing (MT).

As Guillaume Ithurralde, chief technical officer at Testia explains, the most commonly used NDT methods for the manufacture of metallic parts are PT, UT and RT - with ET and UT typically used for the maintenance of metallic parts, and UT and IRT for the manufacture and maintenance of composite parts.

"In Spain, the most common materials used in aerospace are composites, and therefore the most used NDT method is UT. Metallic materials are inspected mainly with Eddy Current and Penetrant Testing," adds Pedro Serrano Cadahía, managing director at ENSIA (Testia Spain).

Elsewhere, Gary Reay, NDT engineer at Leonardo confirms that the company uses "all of the recognized common methods," including ET, MT, PT, RT and UT. These are supplemented with other less common methods including Etch Inspection Testing (EIT) and Bond Testing (BT).

"Methods are chosen depending on the specific design requirement, material type, product topography, and production or repair setting," says Reay.

LIFECYCLE VARIATION

Meanwhile, Henning Juknat, global communications leader at Waygate Technologies, points to three main NDT technologies and methods: remote VT and inspection, UT, and industrial RT and computed tomography (CT). These inspection technologies are used

1 // Phoenix Power|scan HE is a 9 MeV linear acceleration CT scanner able to scan large complex parts *(Photo: Waygate)*

to test initial materials, as well as finished aircraft components - and are also being used as part of in-field maintenance and repair processes.

"Which technology is used for inspection will vary within this lifecycle. Visual inspection, CT and UT all have certain strengths in inspecting specific materials and detecting different defects," says Juknat.

"Next to the material, the shape of the part and its state and location of assembly may play a role. For example, industrial CT systems can be best used to inspect individual turbine blades, while the same blade as part of an engine on a wing might be better suited to remote visual inspection, borescope or ultrasonic inspection," he adds.

RECENT INNOVATIONS

Juknat notes it is difficult to point to any single development in NDT as the most important in recent years. However, he believes that "innovations that have provided better images for greater detection capabilities have had a big impact in recent years". Digital and AI solutions like assisted defect recognition have "significantly sped up inspection and reporting processes while opening inspections up to personnel without expensive training and certifications".

"The use of large-scale composite materials with complex internal structures, which can hide defects from traditional methods, have posed inspection challenges. Large and heavy samples, such as 3D-printed turbine components, require high penetration energy for thorough inspection, compounded by their complex geometries and internal structures," Juknat says.

High-energy computed tomography (CT) systems – including those that use a linear accelerator to generate high-energy x-rays are becoming "essential" for inspecting such large and heavy samples with dense and thick components, which "could not be inspected with traditional methods", says Juknat.

Phased Array Ultrasonic Testing (PAUT) also facilitates the inspection of large-scale composite materials with complex internal structures. An example of a PAUT system is Waygate's own Krautkrämer RotoArray comPAct, which Juknat says provides "detailed internal images of components and allows inspectors to locate and characterize defects with precision."

"We have also moved the PA technology directly into the probe so that inspectors can connect the probe directly to their tablet or phone to perform the inspection and send or file results much faster," he adds.

The aerospace sector is typically conservative when adopting NDT innovations, instead relying on well-proven technologies for inspection, but always aims to improve productivity and extend the lifetime of components.

"It takes time to trial, test and validate new technologies. Waygate Technologies has developed close relationships with end users to ensure a deep understanding of the challenges and opportunities and in turn the continued investment in the right areas," Juknat says.

DIGITAL RADIOGRAPHY

Reay believes that digital radiography has had the most significant impact on Leonardo among recent

2 // The RotoArray comPAct's roller probes enable the ultrasonic inspection of large scale composite materials while offering connectivity and portability *(Photo: Waygate)*

> **“There needs to be greater understanding around the advantages and limitations of each method, and the benefits of using multiple methods to complement each other”**
>
> **GARY REAY, NDT ENGINEER, LEONARDO**

technological innovations. In particular, he notes that the introduction of computed radiography for the inspection of critical rotor components and assemblies “offered a big cost saving in terms of consumable materials, disposal of waste, and storage of images”.

“The process is no quicker, and process control is more intensive, but image evaluation is more detailed allowing for more accurate reporting,” he says.

Although Leonardo has not yet found an opening for PAUT in its business to date – mainly because the company’s product designs “do not lend themselves to this technique so well” – Reay also observes that there have been “significant advances” in conventional UT test sets and systems that have made work more accurate. “The Sonatest Wave test set has enabled more reliable and repeatable inspections by the conventional UT Type II technique,” he says.

Meanwhile, Ithurralde highlights two main innovations at Testia – the digitalization of ET, RT, UT and VT systems, and the automation of data acquisition and post-processing systems, particularly following the adoption of NDTkit software. “PAUT increases data collection by a factor ranging between five and ten. It also brings traceability, which provides a good surface coverage. Digital x-ray is very interesting, especially for components requiring multiple shots. But both techniques require advanced operator skills,” he says.

“The most innovative software is the NDTKit, which allows most of the main companies and Tier Ones to use and share the same analysis software, at least for UT and RT – and for IRT and ET very soon. In the manual inspection field, it is also important to mention the robustness of some tooling like the UE1 that allows the inspector to have two NDT methods in one software package,” adds Cadahía.

Here, the UE1 - as well as the portable (Smart UE1) version and the technological brick (UE1 Box) version – refers to a multi-method inspection tool used by Testia that combines UT and ET capabilities in a single device.

“This makes them quite versatile for aircraft inspection purposes - all the other devices in the market are dedicated to just one method, either Ultrasound or Eddy Current,” says Cadahía.

SAFETY AND EFFICIENCY

The use of NDT in manufacturing, development, or maintenance exerts a significant impact on safety and efficiency.

Notable examples include the LineTool, LineMAP and LineSizing systems, first specified and prototyped by Airbus, then industrialized by Testia. Ithurralde says these tools enable users to tackle the lack of certified UT inspectors at airports. For example, if an A350, which features an airframe made of CFRP, needs to be inspected after an impact.

In terms of overall efficiency, Reay also points out that Leonardo’s recent procurement of a

Flex
Waygate Technologies

2

> **“The aerospace sector is typically conservative when adopting NDT innovations but always aims to improve productivity and extend the lifetime of components”**
>
> **HENNING JUKNAT, GLOBAL COMMUNICATIONS LEADER, WAYGATE TECHNOLOGIES**

dual-robot, high-speed, 14-axis UT system will change the way NDT is viewed in the company by providing reduced inspection times and more accurate reporting. “It also ensures that the business is ready for parts in the future that come with increasing complexity, and cannot be inspected using conventional techniques,” he says.

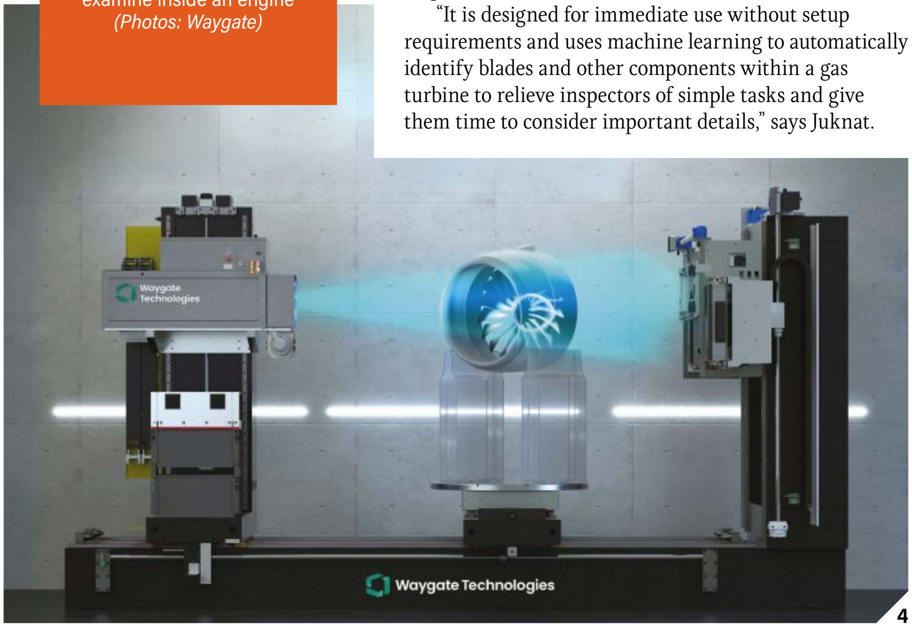
According to Juknat, engine inspections are another key area in which the increasing demand for Maintenance, Repair, and Overhaul (MRO) services in the aerospace industry is pressuring operators to optimize processes without compromising safety.

A solution he points to that addresses this issue is the Everest Mentor Visual iQ+ (MViQ+) video borescope, a Waygate device that uses AI-enabled analytics to automatically count blades and recognize and categorize defects to improve data quality and streamline critical inspections.

“It is designed for immediate use without setup requirements and uses machine learning to automatically identify blades and other components within a gas turbine to relieve inspectors of simple tasks and give them time to consider important details,” says Juknat.

3 // The Everest Mentor Visual iQ video probe can use AI to identify defects

4 // CT scanners are able to examine inside an engine *(Photos: Waygate)*



KEY CHALLENGES

Whenever new products or materials are introduced, Reay notes that the main challenge always resides with the designers, who he says insist on being informed of every discontinuity present. He also confirms that composites represent a problem because they do not always conform to the normal rules of NDT.

“Complex structures of hybrid materials represent significant challenges, and our experience shows that many new equipment introductions – whilst encouraging – do not always provide any more capability than our existing equipment,” says Reay.

In addition, Reay observes that additive manufactured parts create additional challenges because of grain structure, surface finish, and topography. “There is still much work to do before this challenge is conquered,” he says.

“Regarding standards and regulations, our internal procedures ensure that international specifications and regulatory documents are embedded into our requirements. This is regularly tested through an extensive audit program,” he adds.

“The implication of non-compliance is additional work to correct the non-conformance, operator training, procedural amendment, or worst case scenario, suspension of the process.”

For Ithurralde, the main challenge currently facing the NDT sector is the scarcity of certified operators. Even so, he points out that compliance with aerospace standards is still ensured thanks to best-in-class training centers and a lot of monitoring conditions for the operators.

“The implication of non-compliance is structure failures, which can be dramatic,” he says.

COMMON MISTAKES

Reay thinks the most frequent misconception relating to the use of NDT in aerospace is that it can reveal all the defects in a material. “Outside of the NDT world x-ray is often seen as the cure-all, but there needs to be greater

DISCOVER THE LATEST WEBINARS FROM AEROSPACE TESTING

TO LEARN MORE ABOUT OUR DIGITAL
ROUND TABLES AND MANAGED
WEBINARS CONTACT TOM EAMES
Tom.Eames@markallengroup.com

SPONSORED BY
EMERSON
HOSTED BY
Aerospace TESTING INTERNATIONAL

DIRECT OBTAINING VALUE FROM A MODEL BASED TEST WORKFLOW?
WEBINAR – TUESDAY, SEPTEMBER 3, 2024
4PM BST | 5PM CEST | 11AM EDT | 8AM PDT

GREG SUSSMAN,
BUSINESS DEVELOPMENT MANAGER
AEROSPACE, DEFENCE, AND GOVERNMENT

SPONSORED BY
4D Technology
innovmetric
University of Sheffield AMRC
SPIRIT AEROSYSTEMS
HOSTED BY
Aerospace TESTING INTERNATIONAL

QUALITY INSPECTION AND MEASUREMENT IN AEROSPACE EMBRACING NEW TECHNOLOGIES AND TAKING ADVANTAGE OF INDUSTRY TRENDS
THURSDAY 12TH OCTOBER 4PM BST | 5PM CEST | 11AM EDT | 8AM PDT

Dr Erik Novak,
Vice President and General manager at 4D Technology, a subsidiary of Onto Innovation

Jean-Sébastien Blais,
Global Expert, Enterprise Solution Deployment, Innovmetric

Rob Hewison,
Technical Manager for Composites, University of Sheffield AMRC

Tom O'Hare,
Technical Fellow
Spirit AeroSystems

NDT WEEK ONLINE
HOSTED BY
Aerospace TESTING INTERNATIONAL

NDT WEEK
TUESDAY 9TH - THURSDAY 11TH JULY 2024

SPONSORS
CarestreamNDT
comet x-ray
TWI
Eddyfi Technologies
TESTIA

IN PARTNERSHIP WITH
ASNT
BINDT
NDTMA
SPIRIT AEROSYSTEMS
Gulfstream
NIAR

HOSTED BY

Aerospace
TESTING
INTERNATIONAL

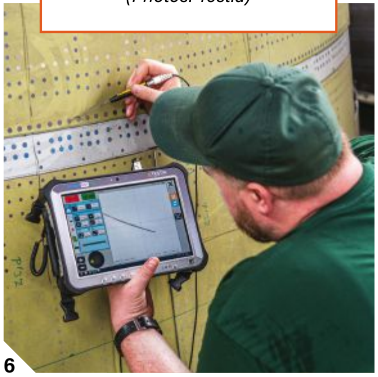
5

> **“The main challenge currently facing the NDT sector is the scarcity of certified operators”**
>
> **GUILLAUME ITHURRALDE, CHIEF TECHNICAL OFFICER, TESTIA**

5 // Inside an aircraft fuselage assembly, an inspector conducts NDT of the ceiling panels using a handheld scanning tool (*Photo: Testia*)

6 // Referring to the Smart UE1’s tablet interface, an NDT inspector performs ultrasonic testing on a section of aircraft skin

7 // A specialized test piece fitted with multiple calibration pins undergoes NDT inspection using Testia’s Smart UE1 *(Photos: Testia)*



6

understanding around the advantages and limitations of each method, and the benefits of using multiple methods to complement each other,” he says.

“Education is the key, and training for non-NDT engineers to provide some generic knowledge can be beneficial. The only other advice for young engineers particularly is to lean on the expertise of the experienced Level 3 personnel,” he adds.

Meanwhile, Ithurralde points to situations where engineers could potentially make an incorrect diagnosis despite doubts. In such situations, he urges them to share information with peers or ask for a second inspection.

“The most common mistakes are due to human factors. It is extremely important to stick to technical procedures and if that is not possible then stop, raise a hand, talk to your supervisor, and try to get a solution to the problem at hand,” adds Cadahía.

NEW POSSIBILITIES

Looking ahead, Cadahía predicts that AI and machine learning will be a key technology for automatic inspections in the future, mainly to decrease the number of hours of analysis.

“This is something that could be done automatically as it is already being done in a lot of applications today. In addition, the use of sensors in the manufacturing of components will be key to reducing the number of indications,” he says.

Elsewhere, Ithurralde notes that robotics has already influenced NDT a great deal and that AI will do the same, as long as users build robust learning data sets hosted on the cloud and monitor the outputs properly.

“Future trends include more connectivity, more cybersecurity and more methods to qualify AI,” he adds.

Meanwhile, Reay predicts that the future holds promise for NDT – and that emerging technologies like AI and robotics are likely to play a much larger part in testing systems.

“Technology moves so quickly in all our lives, so I see a big role for AI in the evaluation of parts, providing less reliance on the human – the biggest source of mistakes in the industry,” he says.

“Robotics are already in use in many organizations, but this will only develop further as business demands greater efficiencies and cost reduction,” he adds.

Juknat agrees that, as we venture further into the future of aviation and space exploration, advanced inspection technologies will continue to be pivotal – particularly because new materials and propulsion technologies will call for continual adaptation in methods of inspection.

“The evolution of AI and machine learning is set to unlock new possibilities for enhancing efficiency and thoroughness in inspections. We can expect to see sophisticated technologies enable more insightful data from connected inspection equipment, assisted and automated workflows and integrated platforms and collaborations,” he says.

“Regardless of what the future holds, the field of aerospace inspection will remain critical in driving progress in the industry, ensuring safety, quality and productivity,” he adds. \\

7

Suppliers come and go, putting NDT systems at risk.
We make NDT systems obsolescence proof with NDT Suite.
Any Instrument. Any Motion System. Any File Format.

NDT Suite

powered by: InspectionWare

As NDT vendors come and go, our software will keep your production running.

SCAN manages your setup and collects data from a wide variety of popular NDT instruments.

EVALUATE imports a wide variety of data types for analysis with intuitive measurement tools and customized reporting.

PLAN maps out scan lines on imported CAD models, for easy creation and editing of scan path programs.

AUTOMATE integrates your NDT system with factory databases, PLCs and robots.

UTEX SCIENTIFIC

www.utex.com | 1-800-663-8839

Specified by Fortune 500 companies to automate and improve their NDT processes. Used globally by universities, labs, and companies of all sizes.

NEW PRESSURE SCANNER UNVEILED FOR FLIGHT TEST MARKET

Miniature pressure scanner represents a leap forward in aerodynamic measurement technology

Evolution Measurement has launched the EvoScann P10-D pressure scanner, developed in line with the EU-funded CleanSky2 and Airbus Helicopter-led RACER program.

Building upon proven EvoScann technology, the P10-D was developed over several years and delivers the first-ever 10-channel true-differential pressure scanner for in-flight aerodynamic testing.

Designed to meet the demands of aerospace applications, the EvoScann P10-D features a fully customizable mechanical interface so it can be integrated into different testing configurations, often without the need for any tubing.

The pressure scanners can be connected in a daisy chain configuration, reducing the cable length required and delivering readings from each scanner. This improves frequency response and streamlines operations.

According to Evolution Measurement, the EvoScann P10-D offers the highest resolution available in the market, while the P10-D's ten direct true differential pressure sensors are coupled to a 24-bit ADC.

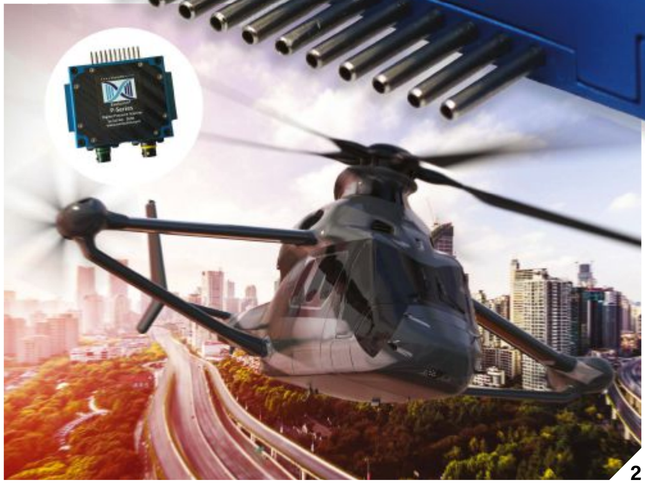
Various measurement units allow measurement output speeds of up to 2kHz. Pressure signals are fully temperature compensated, and the P10-D incorporates an additional barometric sensor that is only used for measuring local atmospheric pressure.

This measurement does not form part of the differential measurement and can report barometric or static pressure changes at multiple locations around the test article when multiple scanners are deployed.

Its robust construction ensures reliability under the most challenging conditions, while its aerospace-specific communication protocol guarantees efficient data transmission during flight tests. The EvoScann P10-D uses IENA communications, is IEEE1588PTPv2 compliant and is accurate to within ±0.1%.

EvoScann®
P-Series
Digital Pressure Scanner
www.evoscann.com
1 < < < Channels < < < <

1



2

Airbus' RACER is a compound helicopter that features two box wings with lateral rotors as well as the main rotor on top, and an asymmetric tail boom. The helicopter is powered by two Safran Aneto-1X engines.

The helicopter, which is currently being flight tested by Airbus in Marignane, France, surpassed its targeted top speed just seven flights and nine hours into its two year campaign last June.

The target fast cruise speed of 253mph (407km/h) was passed on June 21, less than two months after Racer's first flight, when Airbus Helicopter's chief test pilot Hervé Jammayrac, pushed the aircraft to a speed of 260mph (420 km/h) during a test flight.

The flight test team has also already opened up 80% of Racer's flight envelope, flown without autopilot in cruise and performed steep banking maneuvers at speeds above 230mph (370km/h)

RACER is part of the Clean Sky 2 project, which emphasizes environmental sustainability in aviation, and the P10-D aligns perfectly with its goals by enabling more efficient, accurate, and adaptable testing processes. Addressing the unique challenges of flight test environments, the P10-D empowers engineers to push the boundaries of innovation in cleaner and greener aviation technologies, said Evolution Measurement.

Andover, UK-based Evolution Measurement also works in industries including motorsport, power generation and universities and research establishments. Manufacturing the highly successful EvoScann range of miniature pressure scanners, the team has a vast knowledge of Aerodynamic testing, particularly in the Automotive industry and are available to offer advice and support as required. \\

1 // The EvoScann P10-D scanner has a customizable mechanical interface

2 // The EvoScann P-10D pressure scanner was developed in line with the RACER compound helicopter program

FREE READER INQUIRY SERVICE
EVOLUTION MEASUREMENT
For more about this advertiser, visit www.magupdate.co.uk/pati

SWISS STUDENTS ACHIEVE EUROPE'S FIRST REUSABLE ROCKET HOPPER

Kistler supports the Gruyère Space Program with vibration and thrust testing for its VTVL hopper

1 // The Gruyère Space Program conducted rocket thrust testing with the support of measurement technology from Kistler *(Photo: Gruyère Space Program)*

The Gruyère Space Program has achieved its goal of building Europe's first free-flying rocket hopper. Named Colibri, GSP's reusable liquid rocket hopper launches vertically, navigates freely, and then lands safely on the pad.

Supported by Kistler measurement technology, the GSP team has completed rocket thrust testing and vibration monitoring to optimize propulsion and control algorithms.

The story begins when Jérémy Marciarq, Julie Böhning, and Simon Both discovered their shared passion for spaceflight in high school. They joined the École Polytechnique Fédérale de Lausanne (EPFL) in November 2018 and started experimenting with small 3D-printed models. After setting up an association to develop a Vertical Take-off, Vertical Landing (VTVL) rocket hopper, they named themselves the Gruyère Space Program (GSP) after their home region in western Switzerland. Operating from a barn in Lessoc, GSP soon professionalized and attracted over 60 sponsors, including the Kistler Group.

CRITICAL SUPPORT WITH TESTING

Colibri, the reusable VTVL rocket demonstrator is 2.45m (8ft) tall, powered by a bipropellant liquid rocket engine (N20 and IPA) that generates up to 1.25kN of thrust and has a 3kg (6.5 lbs) payload capacity.

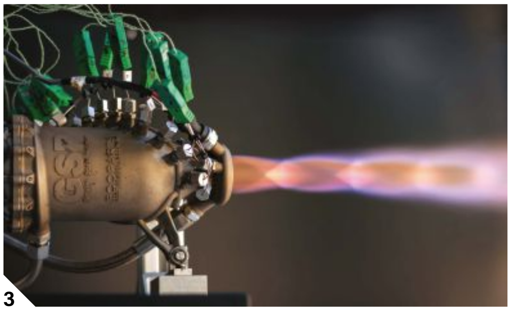
2 // Rocket thrust testing used a 9333A piezoelectric force sensor from Kistler, mounted directly in front of the rocket's injector head *(Photo: Gruyère Space Program)*

During testing, GSP used three different sensors from Kistler: A piezoelectric press force load cell 9333A for thrust testing and characterization, mounted directly in front of the injector head with a measuring range (Fz) of 0 to 50 kN; A piezoelectric pressure sensor 601CAA, which was installed in a small channel leading from injector head and the combustion chamber, supplied essential pressure monitoring data, and a triaxial accelerometer 8763B was used for vibration monitoring and analysis.

It was only after the vibration compensation – achieved by control algorithms based on the accelerometer data – had been integrated that the hopper was able to maintain a steady position.

PAVE SPACE

The GSP team had grown to 15 members by October 2024, joining from all over Europe. Colibri completed 53 flights at varying altitudes with special maneuvers and different payloads – ending with a safe landing every time. On completing this free-flight campaign, GSP became the first student project to design and launch a reusable VTVL rocket.



3 // GSP's Colibri VTVL rocket is equipped with a bipropellant liquid rocket engine (N20 and IPA) that generates thrust of up to 1.25 kN *(Photo: Gruyère Space Program)*

Kistler's sponsorship included the sensors themselves as well as a complete measuring chain featuring KiDAQ hardware and jBEAM software. KiDAQ is the universal data acquisition system that offers intuitive configuration and automatic synchronization for all connected sensors. Up to 13 modules plus a controller can be integrated in one flexible housing (portable, rack, or DIN rail), capturing more than 20 different signal types. jBEAM is Kistler's fast, powerful measurement data analysis software that supports data import from over 100 file formats. It offers versatile visualization, advanced analysis features, and automated reporting capabilities.

Following GSP's demonstration of the VTVL rocket hopper, members of the team who had now graduated from EPFL went on to found their own company: PAVE Space, which is located in Renens near Lausanne. Drawing on GSP's expertise, PAVE Space pioneers space logistics using its GNC (Guidance, Navigation and Control) algorithms and propulsion know-how for docking technology. \\

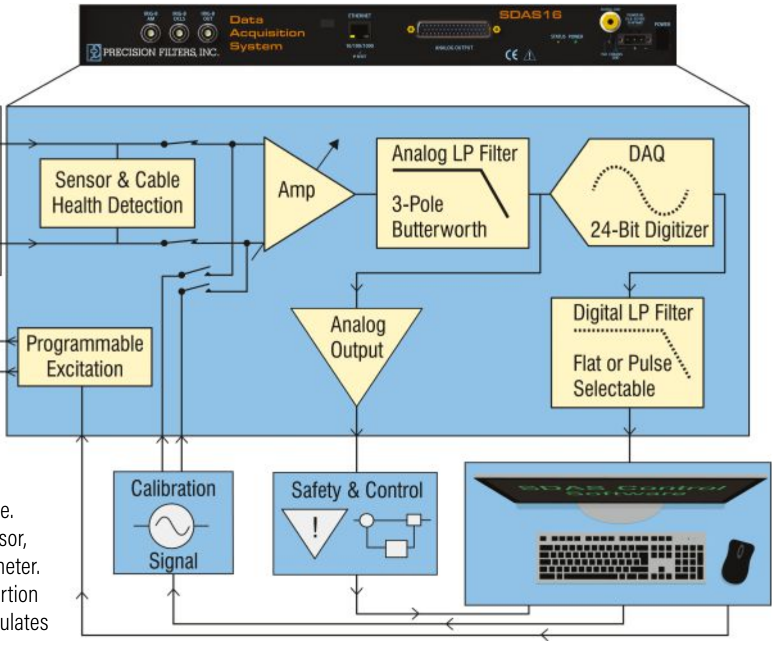
FREE READER INQUIRY SERVICE

KISTLER

For more about this advertiser, visit www.magupdate.co.uk/pati

BUILDING ROBUST VALIDATION TECHNOLOGY INTO A COMPLETE DAQ

The SDAS data acquisition system combines industry-leading signal conditioning, modern A/D conversion technology, and extensive self-test capability in a single package



1 // SDAS Data Acquisition System

Ensuring accuracy and validity in mechanical testing and measurement operations requires more than simply connecting an analog sensor to an A/D converter. Test engineers must verify proper operation across the entire measurement chain, from the sensor through the analog conditioning circuitry to the digitizing hardware and visualization software. Potential sources of measurement corruption are manifold – particularly in harsh test environments – and often not recognized until data are recorded and analyzed. For tests that are not easily repeatable due to long setup lead times and preparation, such critical errors are costly and unacceptable.

The Precision Filters (PFI) SDAS family of data acquisition systems was designed to ensure end-to-end performance of the measurement system can be easily and efficiently verified prior to data collection. In addition to combining the industry's most advanced 24-bit sigma delta A/D architecture with an analog signal conditioning front end that is unmatched in the data acquisition market, the SDAS features built-in verification, validation, and calibration capabilities that enable operators to identify and correct problems at test time. These capabilities go beyond the SDAS hardware itself to ensure the health of measurement sensors and interconnecting cables. Importantly, these features are integrated into a single control system dashboard that provides simultaneous monitoring of measurement system performance with output data displays.

Consider strain gage measurements, which commonly employ complicated wiring schemes with long cable runs, multiple connection points, high-temperature and high-impedance small diameter wires, and sometimes even slip rings. Each of these presents a potential source of error which, collectively, adds significant uncertainty to the measurement of strain. For example, a sudden increase in gage resistance is often a sign of gage failure. To monitor this possibility, the SDAS provides real-time monitoring of the total "loop resistance" in the measurement circuit, which can be continuously compared to a preset limit and alert the user to signs of an impending gage failure.

Or consider a charge-type sensor, such as a piezoelectric accelerometer. The SDAS is equipped with T-Insertion capability, which electrically stimulates the attached sensor to output a known proportional charge signal that can be tracked through the signal chain for end-to-end verification of measurements made by the sensor.

The cables connecting a high-speed measurement chain are often overlooked – that is, essentially treated as "lossless" with perfect signal transmission – but can interact with the measurement sensor to cause unintended electrical filtering. This can reduce measurement bandwidth and, in extreme cases, may require shortening cable runs or modifying the sensor used. For this reason, the SDAS provides the ability to measure this "cable roll-off" prior to test time, showing the user the effective bandwidth over which signal attenuation is less than a desired value, for example 5%.

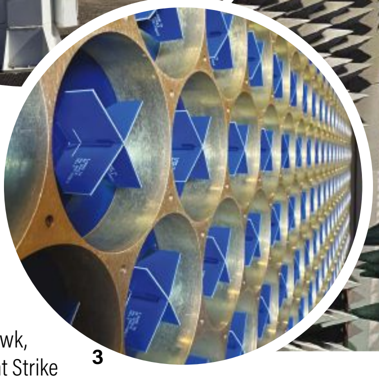
The SDAS also includes automated Go/No-Go and Factor Acceptance Test (FAT) routines that have long distinguished PFI's analog front ends. The Go/No-Go uses calibrated DC and AC substitution voltages to quickly verify proper operation of the unit prior to commencing a measurement. All data critical system parameters are measured and confirmed, including channel gain, sensor excitation levels, DC offset, noise, and common mode rejection (CMRR). These tests are NIST-traceable and the results recorded for documenting quality assurance.

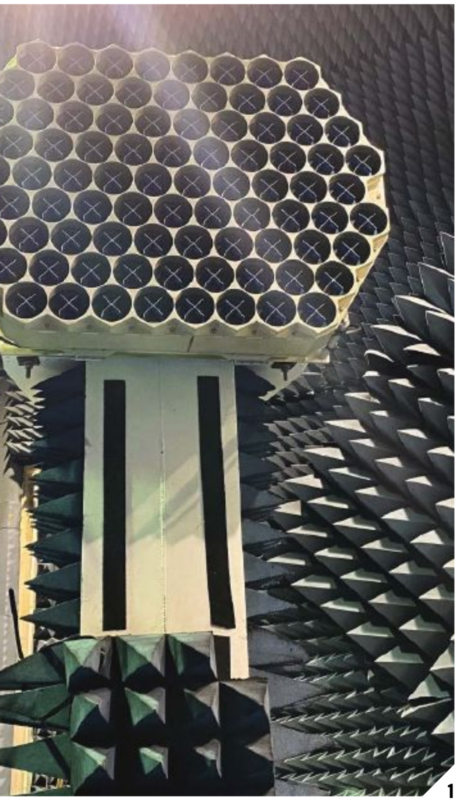
The FAT adds yet another layer of measurement validation by automating a NIST-traceable test sequence that makes use of an external test subsystem to sequentially verify an extensive set of performance benchmarks. The SDAS test subsystem easily integrates with the main unit and is programmed, along with the Go/No-Go and other performance checks described above, from a single desktop software client. \\

FREE READER INQUIRY SERVICE
PRECISION FILTERS
For more about this advertiser, visit www.magupdate.co.uk/pati

PHASED-ARRAY TELEMETRY FOR MULTI-TARGET AIRBORNE MISSIONS

Phased array system delivers high-speed, multi-target telemetry with digitally controlled analog beamforming





1 // AirRAPTR in an independent, 3rd party near field chamber being patterned

2 // Dual 8-beam RAPTRS integrated with a TALON positioner to support a multi-target salvo test event

3 // RAPTR's front end

The Raven Advanced Phased-array Telemetry Resource (RAPTR) is the industry-leading multi-target telemetry collection asset for the modern range. The fundamental technology uses analog beamforming techniques but with a twist – the components are digitally controlled. Raven Defense has been able to leverage Research and Development (R&D) by the telecommunications community to enable their 5G networks. The commercially available beamforming backbone of RAPTR is classified EAR99 (no license required), Designated 5A991.g by the Export Administrations Regulation - in other words its exportable!

This hybrid architecture enables a high-speed scanning electronically steered phased array that outputs dual polarized analog RF, thus providing the full beam bandwidth product, 3.2GHz for an eight-beam system in S-Band. The array has a Field of View (FoV) of +/- 45° degrees in both azimuth and elevation and scans the entire band within the FoV at 3kHz. In a nominal configuration, the array has one beam dedicated to continuously scanning the FoV; effectively serving as an RF camera that steers the data beams to the targets that it detects.

Raven Defense developed the RAPTR technology to help its customers simplify complex missions by reducing the number of airborne assets through a single array. The technology's first use was at the Atlantic Test Range (ATR) where they identified a need to support multi-target missions using a long-endurance, low-speed aircraft.

The Bassler Turbo BT-67, a heavily modified DC-3 aircraft outfitted with turboprop engines, a glass cockpit, extended wings, fuselage, and tanks was selected as the host platform. The nosecone radome of the aircraft is large enough to fit an antenna, and the first article RAPTR, dubbed Air-RAPTR, was scaled to maximally occupy the cross-sectional area of the aircraft at the nosecone, or 84 elements which achieved a G/T of 2dB/K.

Air-RAPTR was delivered on time in the summer of 2020 at the height of the pandemic and has been proven in the field now for over four years having supported Tomahawk, Small Diameter Bomb, Joint Strike Fighter, and various hypersonic test events without a single failure. Air-RAPTR has subsequently been replatformed to a De Havilland Canada Twin Otter, where it continues to support the ATR mission.

Subsequent variations of RAPTR are installed on RQ-4 Global Hawk, MQ-9 Reaper, and Gulfstream G-IIISP, which is a testament to its versatility. It's low size, weight, and power make it the ideal telemetry asset for any airborne platform. It easily scales to fill an available volume while the power requirements modestly increase. Its versatility makes it suitable for any test architecture because it can be fitted on almost any platform, and has been successfully mobilized on land, at sea, and in the air.

RAPTR's wide aperture and high sensitivity means it is suitable as an acquisition aid, and can send cues to other nearby antennas while also collecting data, making it ideal for down-range over-the-horizon scenarios with unpredictable trajectories. The fast-scanning and rapid-track capability makes it suitable for highly dynamic targets, such as fast projectiles from close by. Finally, RAPTR's multiple beams allow for multiple targets, such as salvo missions to be conducted using a single aperture.

Raven Defense has the experience and ability to leverage RAPTR to support most missions and can do it cost-effectively and on an accelerated schedule. It is the only option for airborne platforms on the market today and is the right solution for many scenarios that traditionally require two antennas or more. \\

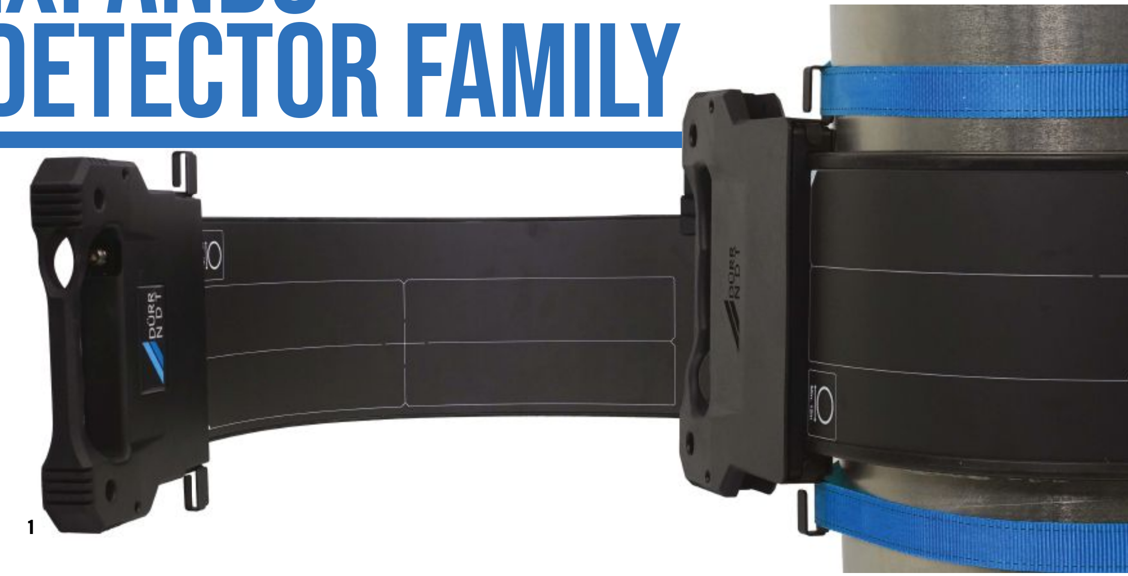
FREE READER INQUIRY SERVICE

RAVEN DEFENSE

For more about this advertiser, visit www.magupdate.co.uk/pati

DÜRR NDT EXPANDS BENDABLE DETECTOR FAMILY

The latest bendable digital x-ray detector for fabrication and MRO



1

Shortly after the launch of the D-DR 1025B NDT, the D-DR 1043B NDT joins the family of bendable x-ray detectors for radiographic testing (RT). The D-DR 1043B NDT is designed for weld and structure inspection on curved objects to cover a wider area and save time due to fewer exposures. With an active area of 97 x 427mm, it is possible to inspect the circumferential weld of an object with a diameter of 300mm with only three exposures.

Both detectors can be bent continuously from flat to a 150mm respectively 300mm diameter in one direction. With exposures possible on both sides the detector can be used on both the outside and the inside diameter of a test object. A simple mounting system allows the detectors to be easily attached to round objects with two straps and then rotated along the region of interest. It is also possible to fix the detectors in a flat position for the examination of straight objects.

With a pixel pitch of 99µm, a basic spatial resolution (SRb) of 100µm is achieved, which means that they even meet the strict DIN EN ISO 17636-2 (Class B) standard for weld inspection. Due to their low weight of 2 kg / 2.2 kg , they are easy to handle and to position.

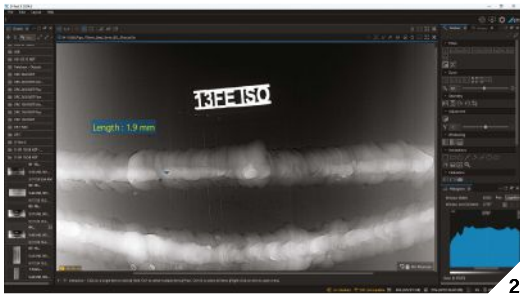
Thanks to the integrated shielding, and unique hardware design the detectors are suitable for X-ray sources up to 450 kV, with a maximum frame time of 180 seconds. As they are dust-tight and waterproof (IP67), battery-powered and have wireless data transmission, they are well prepared for tough NDT applications. In addition to wireless operation, the detector can also be operated by wired data transmission and power supply.

Bendable detectors can replace conventional x-ray films in a range of aerospace applications, for example when inspecting fuselages, landing gear or turbine parts. They can also help optimize inspections through fast image acquisition and software-assisted analysis.

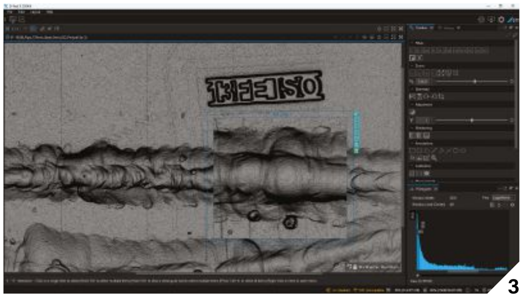
As with all digital X-ray systems from DÜRR NDT, the D-DR bendable detectors are also operated with the latest generation of the proven D-Tect X-ray inspection software. D-Tect X meets the stringent quality standards set by the National Aerospace and Defense Contractors Accreditation Program (NADCAP). Special functions such as multi-gain calibration ensure the highest possible image quality. Powerful and intelligent tools, such as image optimization filters, length and area measurement or one-click ball calibration and wall thickness measurement tools are used to ensure precise and efficient defect evaluation.

D-Tect X also encompasses tools such as automatic duplex IQI detection, contrast to noise ratio (CNR) and signal to noise ratio (SNR) along with the ability to produce a bad pixel report and bad pixel image to quickly perform baseline and long-term stability testing in accordance with ASTM E2737.

Like other industries, the aerospace and MRO sectors are under pressure to reduce costs, while at the same time they are obliged to provide the highest levels of safety and reliability. DR systems continue to improve, advancements in minimum pixel size and improvements in scintillators have improved spatial resolution and contrast making digital detector arrays more broadly accepted in the aerospace and MRO industries. By making the switch from film to advanced digital radiography, aerospace and MRO service companies can ensure the highest levels of safety while improving productivity and profitability. The digital X-ray systems and NDT software from DÜRR NDT are designed to make a decisive contribution to simplifying inspections and increasing efficiency. \\



2



3

1 // Bendable detectors can replace conventional x-ray films in a range of applications

2 // X-ray image with applied X-filter

3 // The image with applied Edge filter

FREE READER INQUIRY SERVICE

DÜRR NDT

For more about this advertiser, visit www.magupdate.co.uk/pati

WHY YOU SHOULD DIVERSIFY YOUR IMAGING TECHNOLOGIES PORTFOLIO

Enriching, reinforcing and expanding your imaging competencies for aerospace applications

Nondestructive testing processes, used with data obtained from aircraft onboard sensors, significantly enhance the reliability of the aerospace industry.

ASNT's Industry Handbook for Aerospace NDT emphasizes this role in the following terms: "The aerospace industry is particularly sensitive to the quality condition of components because of the severity of the consequences of failure during service and the costs of the equipment. From the very beginnings of flight, lightweight and durable materials have been the key to successful aerospace structures. Validation of the quality of the materials and assembly is of utmost importance. Nondestructive testing (NDT) testing plays a paramount role in ensuring that high quality."

Aerospace structures, encompassing aircraft, rotorcraft, spacecraft, rockets, and missiles, possess characteristics that pose significant challenges for NDT methodologies. The table opposite explicates some of these structural and material-related issues.

STRUCTURE ISSUES FOR NDT PROCESSES IN AEROSPACE COMPONENTS AND SYSTEMS

ISSUE	Impacts for NDT Processes
Thin structure	Small discontinuity size criteria result in high resolution/sensitivity requirements for non-destructive testing capability.
Reinforcement	Complex geometries have limited access and boundary edges. Multilayered materials, multiple materials, and nonuniformity are challenges to non-destructive test schemes.
Shape/contour	Aerodynamic, non-parallel and non-flat surfaces require contour following capability.
Temperature	High cost, heat resistant materials can challenge inspection systems for penetration and sensitivity to detail.
Coatings	Paint and coatings can have special requirements for detection sensitivity and thin layer evaluation.
Bonds	Adhesive bond quality validation can be very challenging depending on the design and bonding process.
Propulsion systems	Jet engine components and propellant rocket motor systems require high reliability verified by sensitive non-destructive testing.
Thick components	Casting and forging geometries can have thick sections complicated by microstructural noise.

AN INNOVATOR IN THE AEROSPACE INDUSTRY

Carestream NDT brings an extensive team of experts and experienced professionals devoted to providing integrated solutions in radiographic processes for improved images that effectively and quickly examine objects for safety and reliability.

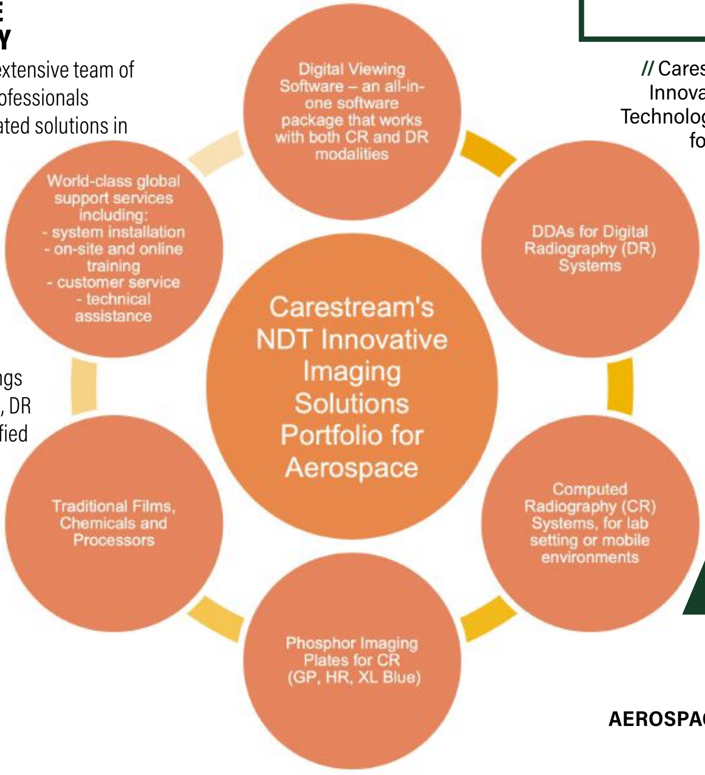
To contribute with the deployment of digital transition roadmaps and strategies the company brings all-in-one imaging software, DR and CR products, BAM Certified ISO-compliant Film, CR and DR products and added value services that include online and classroom training which contribute not only to improve our customer's productivity and profitability at the present but to help build solutions for the future.

Carestream NDT's products and services portfolio is used in a range of industries including aerospace, oil and gas, nuclear, construction, foundry and castings, energy generation, transportation, automotive, military and defense, agriculture, art restoration and museum artifacts.

Carestream NDT's goal is to enable customers to improve their testing processes by providing the right combination of offerings that allow increased capability and reliability of NDT processes to increase quality, safety, productivity, and profitability.

Regardless if it is aerospace systems design, manufacturing and integration of mechanical, electrical, and electronics and hydraulic components or MRO processes, Carestream's portfolio of imaging solutions provide a substantial contribution in: evaluating the well-being of specific aerospace components/systems/systems of systems; predicting the degradation behavior/remaining useful life of those specific components/systems/systems of systems; managing the tasks, people, tooling, material and logistics with the previous two processes; and integrating data from off-line NDT and in-line operational sensors to enhance all stages of the aerospace components/systems development.

All the benefits of our diversified imaging technologies portfolio translate into a workflow that is respectful of the skills of radiographers and is aligned with Carestream's aim to create substantial value for their customers, helping them to continually innovate, adapt and evolve. \\


Carestream's NDT Innovative Imaging Solutions Portfolio for Aerospace
Digital Viewing Software – an all-in-one software package that works with both CR and DR modalities
DDAs for Digital Radiography (DR) Systems
Computed Radiography (CR) Systems, for lab setting or mobile environments
Phosphor Imaging Plates for CR (GP, HR, XL Blue)
Traditional Films, Chemicals and Processors
World-class global support services including:
- system installation
- on-site and online training
- customer service
- technical assistance

// Carestream's NDT Innovative Imaging Technologies Portfolio for Aerospace.

FREE READER INQUIRY SERVICE
CARESTREAM
For more about this advertiser, visit www.magupdate.co.uk/pati

CREATING A SAFE AND SUSTAINABLE METAL ETCHING PROCESS

Metal etching is a critical process used to selectively remove material from the surface of a component via chemical reactions

1 // Scan to select recipe and operating parameters

2 // Overview of an etch process line

3 // Operator safety at process intervention area

The technique allows for precise material removal over expansive areas of complex geometries while maintaining exact tolerances for component dimensions and material grain verification.

The industrial challenges of automating etch processing include maximizing operator safety, plant safety, and environmental safety, as well as precise process control over a process that typically has a level of art – making it difficult to train and sustain throughput at a facility.

Exact process control involving mist collection, fume scrubbing, process effluent control/treatment, process station timing, station etch rates, and safe station operator verification is required to ensure process integrity and safety for all stakeholders.

There are several control considerations involved with a metal etching process. Etch process control needs to occur on a world class chassis that is built to exacting standards and has control automation designed in the product. World class mechanical design of mechanical equipment including the tanks, transporters, air handling, piping, and operator safety space ensures a world class solution delivered for automated processing success.

Safety is designed into an automated etch processing line maximizing efficiency and throughput through LOCKTIME Controls. Design for operator safety is the most important consideration in the control of an automated etch system. Safe operator intervention areas on the line are essential to maximize safe operation, process visibility, and throughput in operation. LOCKTIME curtained protected safety zones in conjunction with stack lights and process monitors around each operator intervention area allow critical process steps to be performed keeping the operator safe. NO automatic motion is allowed in a safety zone during a recipe selected or operator called process check. This means NO overhead or conveying devices can move into a safety zone that is muted, or electrically interlocked safety gate. Stack lights and process monitors keep the factory safe and informed.

Process time tracking and control is set by a library of barcodes in the operation database that represent recipes to ensure correct material removal is achieved per component. Dynamic control of station process time is paramount to maximize the 'life' of the line chemistry and maximize line throughput. This is accomplished by utilization of a planner in the LOCKTIME Control System. LOCKTIME allows for 'on-the-fly' processing adjustments that can be a result of controlled and safe operator intervention. Water break or litmus check, or a planner calculation based on part attributes surface area or weight. The control of the etch system timing in-situ with processing allows for the documentation of the exact processing parameters to make etching safer with less process variability allowing a component manufacturer to maximize processing throughput.

Maximizing throughput requires a control system that is set up to handle dynamic events that occur in etch processes.

Dynamic Tank Control allows individual tanks to be 'blocked' from processing parts or 'disabled' during service without halting the entire operation. Automated Tank Dosing for adjustable chemical concentrations and on-the-fly tank configurations aids in maintaining the proper etching environment. Meanwhile the Infinite Historian feature ensures all processing data is logged, and recipes can be dynamically adjusted and stored using an intuitive user interface.

These features allow for the etch process to be performed with the control system doing the monotonous and dangerous processing steps so the human operator can concentrate on quality and process planned maintenance to ensure process uptime. With LOCKTIME Control, the etch process has become more efficient, reliable, and environmentally friendly. \\

FREE READER INQUIRY SERVICE
REL
For more about this advertiser, visit www.magupdate.co.uk/pati

INNOVATIVE VIBRATION TEST SYSTEMS MADE IN EUROPE

Several innovations have been introduced by Acutronic, which has had 50 years of industry exposure in its vibration test system series, complementing its well-established rate table portfolio. Acutronic is a leading supplier of rate tables used for the development, production and calibration of inertial sensors, inertial measurement units and other integrated systems for active and passive safety, as well as for navigation purposes.

The iMPULSE X-Wings35 shaker series – including 40kN and 60kN air-cooled shakers and 90kN, 140kN and 200kN water-cooled shakers – covers a wide range of environmental tests requiring 40kN to 200kN of force or 120kN to 600kN of shock force.

Introduced in mid-2024 to the market, Acutronic is the first shaker manufacturer to offer digital vibration command input to the power amplifiers, enabling noise-free vibration motion profile testing, as a standard feature.

The company's innovative modular amplifier design is based on SIC (silicon carbide) components – a first in the vibration industry, according to Acutronic. These high-efficiency components significantly reduce thermal loss and energy waste, improve current sharing between the power modules, and offer an increased switching frequency for even smoother vibration motion, compared to IGBT (Insulated-gate bipolar) transistors commonly used in the industry.

The shaker's AcuVibe Commander, a sleek graphical user interface with a touchscreen, ensures safe and friendly operation, providing real-time supervision, monitoring and adjustment of all shaker statuses.

Acutronic's solutions are known for their high accuracy, motion fidelity, system reliability, and availability. Meanwhile, the reactivity and responsiveness of Acutronic's customer international support hotline has also been praised. With growing shaker service expertise and maintenance capabilities in France, Germany, and Switzerland, Acutronic aims to become the preferred supplier in Europe. \\

FREE READER INQUIRY SERVICE - **ACUTRONIC**

To learn more about this advertiser, visit www.magupdate.co.uk/pati NOW!

AVOID HIGH COSTS OF BLOCKED WASTE PIPES

Poor passenger comfort, flight delays, unscheduled maintenance stops, aircraft on ground (AOG) layovers or unnecessary waiting times for passengers due to blocked waste lines are situations that an airline does not want to have to deal with. Aircraft lavatories are often misused by passengers to dispose of items that are not intended to be disposed of via the waste line. Examples include nappies, towels, even pillows and passports, which cause serious blockages and result in unplanned and costly maintenance stops.

Removing these blockages usually involves significant effort, is an unpleasant task for the maintenance team and cannot be done as part of an aircraft turnaround. The quick and easy way to remove foreign objects from the waste lines is the Vacuum Toilet Blockage Remover, VTBR2, developed by TEST-FUCHS. It is the quick emergency solution to prevent unplanned maintenance downtime.

By using strong negative pressure, controlled by the operator, the VTBR2 suctions out any blockage in the opposite direction. The entire process takes just 30 minutes and can be carried out discreetly while passengers board or disembark the aircraft.

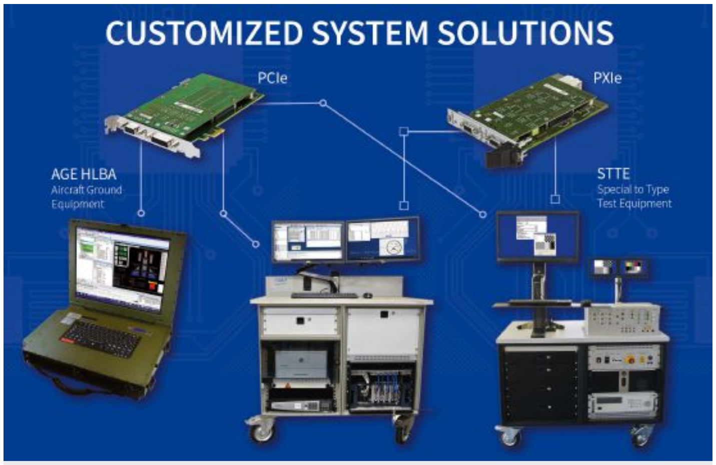
Disassembly of the waste line is not necessary. During the process, the wastewater is collected in a tank large enough for multiple uses and with a large sight glass to help identify the cause of the blockage. No physical contact with the wastewater is required.

The VTBR2 can be used anywhere in the world and is equipped with a powerful electric motor capable of operating universally at 50 and 60Hz. In addition, there is an integrated diesel driven generator, so you do not even need a power connection.

The VTBR2 is the answer to avoid expensive AOG situations caused by waste line blockages. It saves time and keeps the aircraft in operation. \\

FREE READER INQUIRY SERVICE - **TEST-FUCHS**

To learn more about this advertiser, visit www.magupdate.co.uk/pati NOW!


CUSTOMIZED SYSTEM SOLUTIONS
PCIe
PXIe
AGE HLBA
Aircraft Ground Equipment
STTE
Special to Type Test Equipment

CUSTOMIZED AVIONICS TEST SOLUTIONS

Providing dedicated test solutions for a variety of aircraft, helicopters and missile programs is a challenge because project requirements, timescales and delivery requirements are moving at such a fast pace. A solution is to use industry standards to formulate test system solutions with highly flexible, scalable and modular designs.

Inherent in such designs is the need to handle a range of industry-standard data buses and interfaces to be simulated, monitored and correlated data from the avionics sub-systems undergoing integration, test and verification. It is commonplace to see the combined use of avionics interfaces, civil and military applications on a single platform like MIL-STD-1553B, STANAG3910/EFEX, MIL-STD-1760, ARINC429, AFDX/ARINC664P7, ARINC825 (CAN Bus) and other serial interfaces with upper layer protocols.

PC-based hardware from laptops with smart cables, portables to desktops and 19in rack mount solutions can offer a good approach and take full advantage to integrate avionics interface modules into PCIe or PXIe based solutions (see Figure 1).

Some test systems may even require complex procedures to engage and interact with the avionic system under test. Such solutions are being built and delivered to support the most advanced aircraft and missile systems using the combination of AIM's avionics interface technology plus third-party interfaces and industry-standard software solutions known as PBA.pro for Windows or Linux. The AIM PBA.pro Test and Analysis software can integrate a wide range of third-party interfaces and supports automated post-processing like offline filtering with data export handled via scripting.

Finally, a powerful capability of the AIM PBA.pro software is to have all common avionics buses and networks time correlated within one single framework application, solving monitoring, capturing and automated or interactive post-processing as described above. \\

FREE READER INQUIRY SERVICE - **AIM**
To learn more about this advertiser, visit www.magupdate.co.uk/pati NOW!

REVAMPING COOLING HOLE INSPECTION

Advanced optical measurement technology ensures precise, automated inspection of cooling holes, enhancing turbine performance, reliability and safety.

Optical measurement technologies are revolutionizing the inspection of cooling holes, vital for aircraft turbine efficiency and durability. Cooling holes dissipate heat from turbine blades, preventing overheating and extending their lifespan. However, their varied shapes, sizes, and orientations pose challenges for traditional multisensor systems.

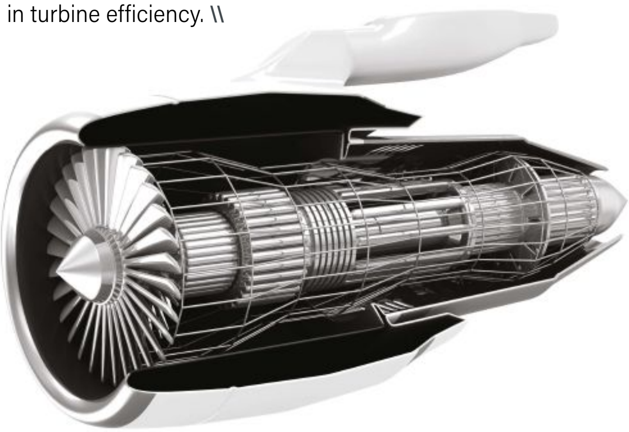
Bruker Alicona's µCMM system simplifies this process with an add-on dedicated to cooling hole measurement. Unlike conventional methods, this optical system delivers comprehensive and precise 3D data for critical parameters, including hole position, diameter, funnel geometry, and minimum cylinder length.

The µCMM system integrates Focus-Variation technology with Vertical Focus Probing, enabling reliable measurements of vertical surfaces and even angles exceeding 90 degrees. Users benefit from up to one million measurement points per scan, ensuring detailed and traceable data for complex hole geometries.

This solution also features a user-friendly software suite designed for automation. With minimal training, users can create digital twins for measurement simulations, collision detection, and automated analysis. Recurring tasks, such as inspecting hundreds of holes based on CAD data, are streamlined with the system's intuitive teach-in process.

Bruker Alicona's innovative approach addresses industry challenges by offering unparalleled ease of use, high precision, and a stable, traceable process. This add-on not only enhances quality assurance but also aligns with the demands of modern, automated manufacturing processes.

With this advanced solution, inspecting cooling holes becomes seamless, reinforcing their role as game-changers in turbine efficiency. \\



FREE READER INQUIRY SERVICE - **BRUKER ALICONA**
To learn more about this advertiser, visit www.magupdate.co.uk/pati NOW!

THE WAY TO FULLY AUTOMATED COMPOSITE PROCESSES

Live monitoring data is a key enabler for fully automated composite manufacturing. Small quality deviations impact production and thus in-line quality control helps to mitigate issues already during production. This is where Testia's In-line Infusion Monitoring comes into play – users can revolutionize their composite quality control, shorten process development time and streamline their manufacturing processes.

Testia's solution for In-line Infusion Monitoring evaluates the flow progress with line sensors, allowing for a space-resolved data interpretation.

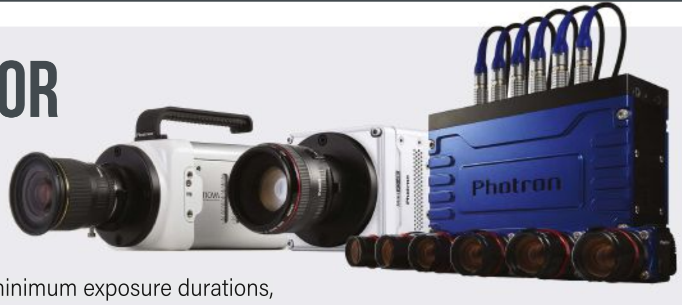
The product provides a customizable solution to boost the digitalization of production. A portable device for process development and an embedded system for industrial process integration is available.

The technology package of In-line Infusion Monitoring combines the monitoring device as well as a software framework. This provides the operator with information on the flow front position, which helps to adapt the process according to the measured data. Customers may choose from different sensor geometries and can select specially designed components. Testia is ready to support from design to implementation: In-line Infusion Monitoring can be integrated into customers' production lines – as a key driver of automated composite quality control. \\

FREE READER INQUIRY SERVICE - **TESTIA**

To learn more about this advertiser, visit www.magupdate.co.uk/pati NOW!

HIGH-SPEED CAMERA RANGE FOR AEROSPACE AND DEFENSE



High-speed imaging has transformed the aerospace and defense industries. For many years, technical professionals have depended upon high-speed cameras, like those provided by Photron, to perform thorough analyses of various rapidly moving events and processes.

The use of Photron's high-speed cameras has been crucial for conducting detailed assessments related to activities such as projectile flights and impacts, missile launches, combustion processes, engine performance evaluations, fuselage integrity measurements, material durability testing, and the movement of various flows or particles among others. These cameras have consistently offered engineers valuable information to gain a deeper understanding of such occurrences.

Buyers of cameras face a wide array of options; hence making an informed choice requires careful consideration of several key factors. Important criteria include frame rate capabilities, light sensitivity thresholds, minimum exposure durations, overall reliability of the camera system itself as well as the reputation of the supplier.

Photron manufactures a variety of high-speed camera models, each designed with distinct features tailored to the research and testing needs of engineers in both aerospace and defense industries. The FASTCAM Nova series from Photron provides capabilities of capturing footage at 20,000 frames per second (fps) while maintaining megapixel resolution, as well as offering 1,250 fps at 4K resolution and 1,440fps at UHD resolution. Beyond our FASTCAM range, Photron is also the sole distributor of the Pharsighted E9 ultra-high-speed series. These E9 cameras are perfectly equipped for tasks that demand visualization speeds exceeding 100,000fps. \\

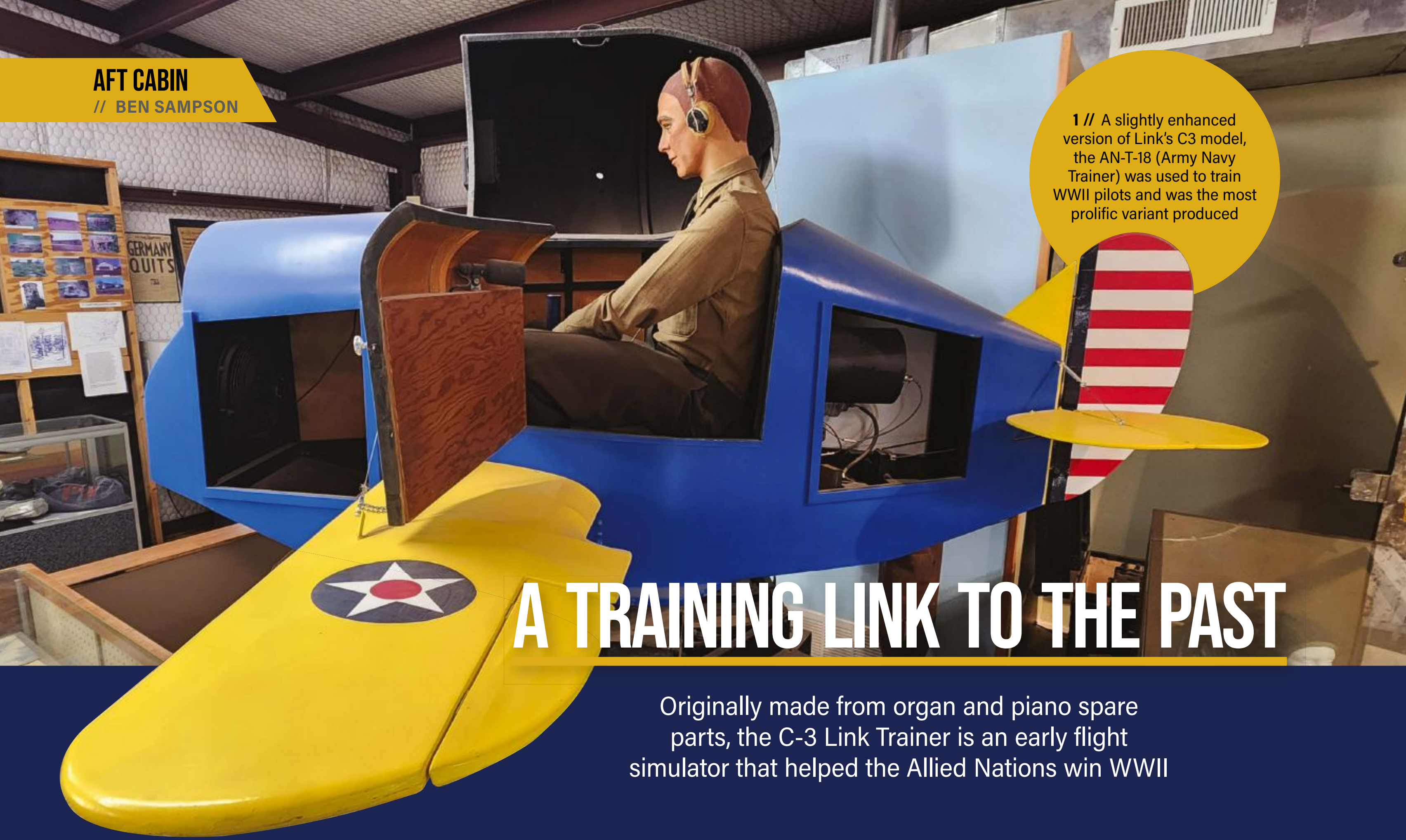
FREE READER INQUIRY SERVICE - **PHOTRON**

To learn more about this advertiser, visit www.magupdate.co.uk/pati NOW!

Index to advertisers

Acutronic	55
Aerofab NDT	79
Aerospace Testing International	47, 85
Aerospace Test & Development Show	29
AIM UK	53
Amentum	Inside Back Cover
Bruker Alicona	55
Carestream NDT	75
Curtiss-Wright	Inside Front Cover
Dewesoft	29
Diversified Technical Systems (DTS)	71
dSPACE	23
DÜRR NDT	71
Evolution Measurement	31
European Test Services	63
HBK	53
Innovmetric Software	45
Kistler	15
Lumistar	9
Magnaflux	77
Netacquire	5
Photron	27
Parker Meggitt	43
Precision Filters	21
Raven Defense	10
REL	Outside Back Cover
Telemetry Services	15
Test Fuchs	63
Testia, an Airbus company	77
UTEX Scientific Instruments	87

// BEN SAMPSON



1 // A slightly enhanced version of Link's C3 model, the AN-T-18 (Army Navy Trainer) was used to train WWII pilots and was the most prolific variant produced

A TRAINING LINK TO THE PAST

Originally made from organ and piano spare parts, the C-3 Link Trainer is an early flight simulator that helped the Allied Nations win WWII

The C-3 instrument flying trainer evolved from Edwin Link's original 1929 "Pilot Maker" which spawned the flight simulation industry.

Link used organ bellows from the Link organ factory, his Father's business in Binghamton, New York in his first design. The bellows were driven by an electric pump to make the trainer pitch and roll as the controls were used.

Commonly known as the "Blue Box", the C-3 is typical of the early trainers used during World War II to prepare more than half a million airmen in thirty five countries for the demands of military service.

The innocuous looking trainer is credited with playing a key role in securing air superiority for the Allies. After WWII, Air Marshal Robert Leckie, wartime RAF Chief of Staff said, "The Luftwaffe met its Waterloo on all the training fields of the free world where there was a battery of Link Trainers".

Manufactured from 1935 to 1941 the C Series trainers featured a full-scale instrument panel with an airspeed indicator, vertical speed indicator, altimeter, magnetic compass, radio compass, tachometer, turn and bank indicator, artificial horizon, directional gyro, and marker beacon indicator. All C trainers were equipped with a throttle, stick and single rudder pedals.

Row upon row of the blunt-nosed, stubby Link Trainers could be found at most military aviation centers in the USA and throughout the British Empire leading up to and during WWII. At Randolph Field in the USA, known as the "West Point of the Air" there was a hangar full. Every Randolph student took more than six hours of Link Trainer "blind flying" instructions.

MORE THAN 10,000 BLUE BOXES WERE BUILT BETWEEN 1935 AND 1949

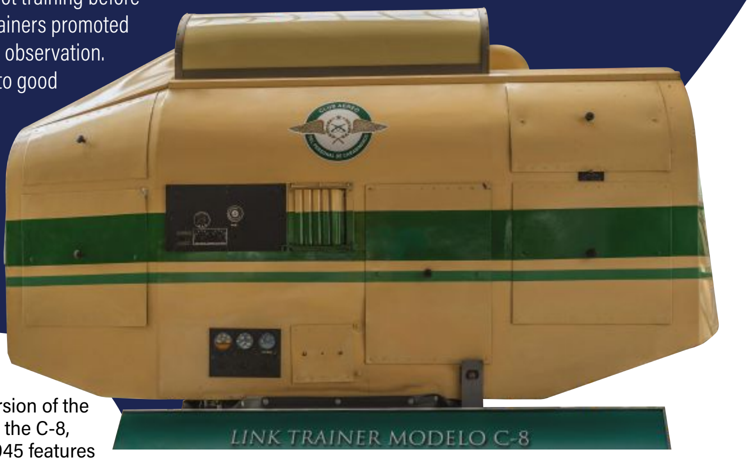
The US Navy also prepared Navy and Marine Cadets at Pensacola, Florida, and other bases with Link training time.

In addition to improving pilot training before leaving the ground, the C-3 trainers promoted using instruments over visual observation. Pilots were no longer limited to good weather, daylight-only flying.

After WWII Link Trainers were also used to train pilots on every airline in the USA for instrument navigation. Most civilian flying schools taught aerial navigation with Link Trainers.

By the 1950s, the increasing complexity and diversity of aircraft and their systems made the C-3 obsolete, except for training for light aircraft. However, later versions of the Link Trainer were used to train the Apollo astronauts for the moon landing. It would not be until the development of computers that simulation systems moved forward significantly, progressing to the immersive systems used today.

The Link Flight Trainer is designated as a Historic Mechanical Engineering Landmark by the American Society of Mechanical Engineers. Thanks to the high number manufactured during WWII, Link Trainers can be found on display in museums and military aviation centers throughout the world, with some even offering training in the vintage simulators. \\



2 // A later version of the Link Trainer, the C-8, developed in 1945 features more instrumentation than previous versions

amentum

Advancing the Future Together

Our innovative aerospace testing solutions, from rocket test stands for space exploration to engine test facilities for hypersonic flight, are paving the way for the future.

On Sept. 27, 2024, Jacobs' Defense, Security, Cyber & Intelligence, and Nuclear business joined Amentum. Visit amentum.com to learn more.

© Amentum All rights reserved.

World Class Systems^{i}

REL, Inc. Automated Anodic Etch Processing Line shown

TRANSPORTER 1 & 2
S1300 AQUEOUS CLEAN
S1400 DI WATER DIP RINSE
Automated Strip Line
Locations
Assets
Notes
Documenta
Automated Str...
Plans
Home
Notes
Assets
Plans
Library
Tasks

SYSTEMS^{i}

World Class Equipment:

- Decades of on-the-job performance

REL Controls:

- Integrated operator safety
- LOCKTIME Coho Control for motion control and PLC's for infrastructure control
- QModoAI integration with LOTO protocols and on demand O&M manual and procedures

Ancillary System Integration:

- Fume Scrubber, Waste Treatment, Chemical Feeds

relinc.com

Made in the USA